Volume III Number 4 1960

CURATOR

A Quarterly Publication of The American Museum of Natural History

CURATOR

Editorial Board

EDWIN H. COLBERT, *Editor-in-Chief*
RUTH TYLER, *Managing Editor*
GORDON R. REEKIE, *Art Editor*
LESTER R. ARONSON
WILLIAM A. BURNS
RUTH NORTON
ALBERT E. PARR
JOHN R. SAUNDERS
HARRY L. SHAPIRO

The American Museum of Natural History
New York 24, New York

ALEXANDER M. WHITE, *President*
JAMES A. OLIVER, *Director*

III/4 1960

293 The Skeletons in the Museum A. E. PARR

310 The Role of the Research Museum in Science

311 Introduction ALBERT C. SMITH

313 The University Museum and Biological Research
HUGO G. RODECK

317 The Museum and Geological Research EDWIN H. COLBERT

327 The Museum and Anthropological Research WILLIAM N. FENTON

355 The Research Museum of the Physical Sciences
ROBERT P. MULTHAUF

361 Seven Lighting Problems; Seven Solutions ROBERT T. HATT

371 Mounting Geological Specimens C. A. SIZER

380 Book Reviews

CURATOR is published quarterly by The American Museum of Natural History, Central Park West at 79th Street, New York 24, New York. It is a journal of opinion, and the views expressed in its articles are not necessarily those of the Museum.

Address correspondence and manuscripts to the Editor-in-Chief. Manuscripts should be typewritten on one side of the page only, with double spacing, and with ample margins. One carbon copy, in addition to the original manuscript, should be sent to the Editor-in-Chief. The Editorial Board reserves the right to reject manuscripts unsuitable for CURATOR, and to return to authors for revision manuscripts and illustrations which are not in proper finished form for the printer. Captions should be typed on separate sheets. Proof should be corrected immediately on its receipt, and returned with the manuscript to the Managing Editor. Authors should leave forwarding directions if they expect to be away from their regular address. Costs for textual changes made by an author after his article is in proof will be charged to him. Each author may have five free copies of the issue in which his paper is published. Reprints may be had at approximate cost. Reprints must be ordered when the galley proof is returned to the Managing Editor. Illustrations will not be returned except by request. Subscriptions are $5.00 a year, single copies are $1.50. Subscriptions in Canada, Newfoundland and all foreign countries are $5.50. Volume III, No. 4, October, 1960.

III/4 1960

The Skeletons in the Museum

A. E. PARR, SENIOR SCIENTIST
THE AMERICAN MUSEUM OF NATURAL HISTORY

Skeletons were among the first objects of museum enthusiasm and curiosity. With a slight air of mystery, they seemed able to tell more about the beast than its mere pelt, pulled over a manikin of dubious realism and accuracy, ever could. Through the study of comparative anatomy pursued by Cuvier and his followers, the skeletons became an inexhaustible source of inspiration for creative scientific imagination. With their natural durability increased by fossilization, they became our main clues to the life of the past. Against the background of an early training in zoology and comparative anatomy, the writer must confess that such a splendid display of skeletons as that in the Galerie d'Anatomie Comparée at the National Museum in Paris, or the excellent teaching collection of the University of Lund in Sweden, have a meaning and an appeal that the finest examples of the taxidermist's art can scarcely equal. In a museum one may also sometimes, and actually not too rarely, see an alert child spend more time in fascination before a skeleton than he gives to a habitat group or some other type of externally complete exhibit. Indeed it is probably the very incompleteness of the skeleton that invites and challenges the mind of the child to complete the picture in its own way in an inner vision.

That an element of morbidity may also, at times, help to arouse public interest in skeletons, particularly the human skeleton, goes without saying. And it is probably to this element that we must credit the attraction

continued on page 296

Fig. 1. A general view of Galerie d'Anatomie Comparée of the National Museum in Paris.

Fig. 1

of the miniature human skulls and skeletons which appear so frequently in the arts of many different and often quite unrelated cultures. Perhaps the most exquisite example shown in any museum is the half-size model of a complete human skeleton carved in ivory, which was presented to King Fredrik III of Denmark in the middle of the seventeenth century and is now exhibited in the National Museum in Copenhagen. This skeleton originally had a scythe in one hand and an hourglass in the other, so that it could serve the dual purposes of a *memento mori* and an anatomical model at one and the same time.

There can be no doubt, however, that skeletons as museum exhibits have suffered a great loss in prestige with the general public. Nevertheless, skeletons still have a lot to teach, and the problem of how to display them to their own and the public's best advantage is one of general interest to all natural history museums.

Sporadic attempts to restore the skeletons to their erstwhile popularity have actually been going on for some time in widely scattered institutions. It may be useful and interesting to review the methods that have been tried and examine their rationale.

It must be taken as a guiding principle of exhibition that an object or a display in order to be effective must also be attractive, unless it possesses an ugliness so extreme as to provide a fascination of its own, as, for instance, in the case of certain ethnographic and archeological materials related to superstitious and cruel religious practices. The witch and the beauty draw our eyes, while homeliness walks unseen. Form and color are the components of visual beauty or ugliness. Of these, form seems to have a relatively independent effect. We will often admire a form but have difficulties in finding the best color for it. The process is almost never reversed.

The value of color seems strictly dependent upon its objective association with form and the subjective associations of the form and color combination with our ideas and memories. The lipstick that makes the mouth more tantalizing looks repulsive on milady's teeth. This is no idle digression. It has a real bearing upon our problem of the skeletons.

Although he has not had an opportunity to subject the idea to experimental tests, the author is firm in his conviction that most people respond quite differently to the same colors in fossil and in "living" skeletons. It seems natural to describe the deep brown color of some fossil bones in approving terms as a rich, dark walnut. Similar hues on the skeleton of a recently deceased animal seem only the discoloration of decay and poor

Fig. 2. From Zoologiska Museet in the University of Lund, Sweden.

Fig. 2

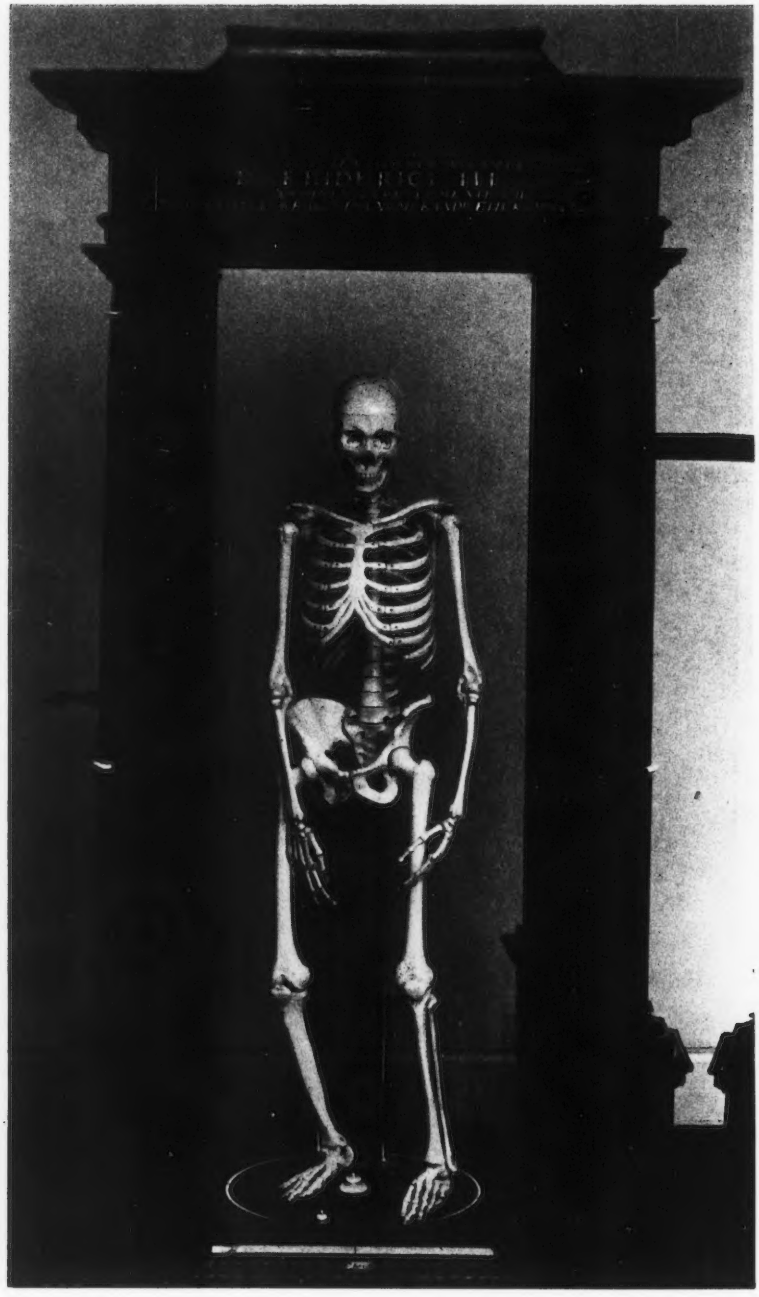


Fig. 3

preservation. We see one in relation to rocks and fine materials, the other in relation to our concepts of cleanliness and health among living things. This leads to the conclusion that the mineral colors of fossilization can, and must, be accepted as they are. They cannot all be equally pleasing, but none is strongly displeasing by its associations, and all have real recognition values. But this is not true of the skeletons obtained from the carcasses of living species.

One of the first things to consider in trying to improve the appearance of recent skeletons on display is therefore their color. Modern methods of preparation generally result in a relatively uniform off-white color. But most large and old museums have valuable mounted specimens which it would be costly, and often destructive, to try to "send back to the cleaners."

When the writer first suggested painting such a skeleton more than twenty years ago, he encountered some very strong objections, ranging from a simple feeling that it would be wrong to alter the "natural" color of the bones, to a deeper, but ill-defined fear that the embellishment of the bones would be a first step on the road to intellectual dishonesty and damnation. But such objections are not too difficult to answer.

Color, as such, is not in any way involved in performing the biological functions of the skeleton. Secondly, the bones of a fair-sized, well-covered animal have no actual color in the total darkness of their natural location. Their color is entirely potential and dependent upon an unnatural exposure to light that can be reflected. Thirdly, if the "natural" color is to be understood as the color the bone would show if exposed to light while the tissues were still alive, this would not be the bone-white of the well-cleaned skeleton, but a shade of pink that would probably seem slightly disgusting to most people, and is not normally shown in any museum. As far as the truth of the functional skeleton is concerned, one color would therefore be as honest as any other. After a mottled old walrus skeleton in the Peabody Museum of Yale University had been painted a peach-pink, the objections fell away, and it became a model for the painting of other discolored specimens.

Whether or not this was the first time a museum skeleton was painted for exhibition may not be entirely certain, but it was the first case known to the writer. It is discussed here at such length because it is a method that does so much for the appearance of an exhibit with such simple means that they are available to anybody at virtually no cost. The paint

Fig. 3. Ivory model of human skeleton of approximately half size, in Nationalmuseet in Copenhagen.

should be entirely opaque, should have a completely dull finish, and should be sprayed on. It is important to remember not to paint any parts that are normally exposed to the exterior and therefore have a true and recognized natural color. This applies to the tusks, teeth, and horns of mammals. It is also true of claws and beaks, if these remain attached to the skeleton. To paint these normally visible parts would not aid but merely confuse the visitor and detract from the appearance of the exhibit.

It should also be pointed out that the painting of an old skeleton serves to reveal its form far more effectively than it was shown before. On a mottled skeleton shades of discoloration and shades of true light and shadows intermingle to the confusion of the observing eye, which may see forms that are not there and miss forms that are actually present, with nothing very clearly defined. On the painted skeleton every shade is a true shadow related only to the form of the bones, which thus stands out sharply and clearly, as shown in the "before and after" comparison of the same specimen in Figure 4.

Beyond the simple question of color lie the intricate problems of posture and of arrangement on display. Probably the grimmest and least appealing of all styles of presentation is the centuries-old tradition of hanging a human skeleton by a brass ring in the top of the skull, with limbs dangling like those of a bandit hanging by the neck. In museums this charming method was often extended to the skeletons of other anthropoids, but could, of course, not be applied to animals with a horizontal spine. For the overwhelming majority of vertebrate skeletons the classical museum pose has been the rigidly symmetric stance of soldiers on parade, with "eyes front," limbs side by side, feet evenly and firmly planted, and tail straight astern, if not dejectedly bending towards the ground. Endlessly repeated, these pathetic specimens can only create boredom if not outright disgust in a modern audience. If the system permits—and this is a very big "if," indeed—any class of objects with a sufficient variety of sizes can, of course, with taste and good luck be arranged in a pleasant pattern. The picture of a case of bird skeletons in the old tradition in the Smithsonian Institution, shown in Figure 5, may serve as an example. But the opportunities to achieve even such a mildly nice effect within the limitations of the system are actually quite rare, and Figure 5 also illustrates the rigid standardization of skeletal posture which was the universal practice in museums until fairly recent times. Obviously, it will take more than an inoffensive or even mildly pleasing disposition of the specimens to kindle an interest in the story of the skeletons among the museum visitors of today. The two most notable and successful efforts to liberate the skeletons from their traditional parade-ground posture have gone forward more or less simultaneously and independently in Basel, Switzerland, and in New York.

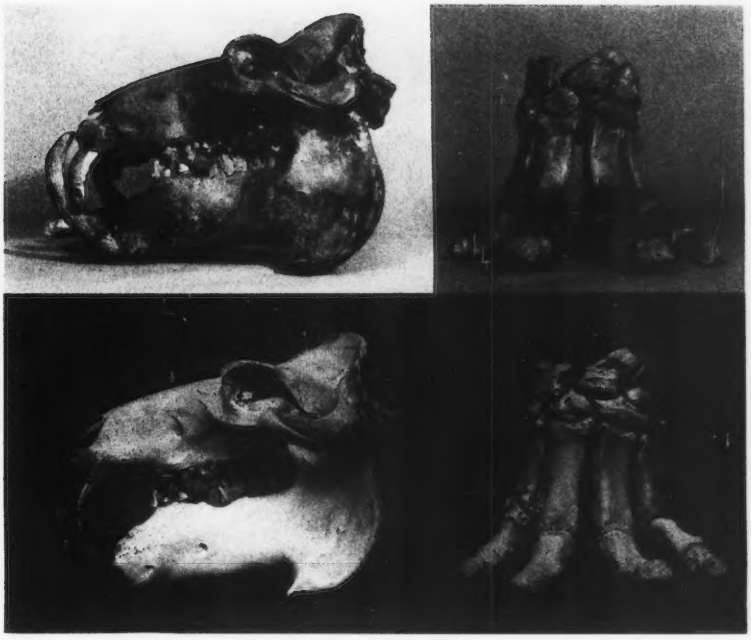


Fig. 4

In The American Museum of Natural History S. H. Chubb spent half a century producing a magnificent series of skeletons poised in action, representing dogs, horses and their relatives, and man. While these prepared specimens, individually, can scarcely be surpassed, institutional indifference has, so far, kept them from becoming vehicles of equally fine innovations in the art of display, leaving each in its separate rectangular glass case in a rather crowded confusion in left-over space.

It is difficult to show any general principles behind the traditional arrangements of skeletons in museum halls and exhibition cases. Usually it was only a matter of finding space among and between the other exhibits, with little thought given to over-all appearance. When things got too crowded, more space could be gained by hoisting the skeletons of aquatic forms such as whales and swordfish up overhead. The simple

Fig. 4. Poorly preserved and badly discolored skull and foot of hippopotamus (above). Same specimens after painting (below).

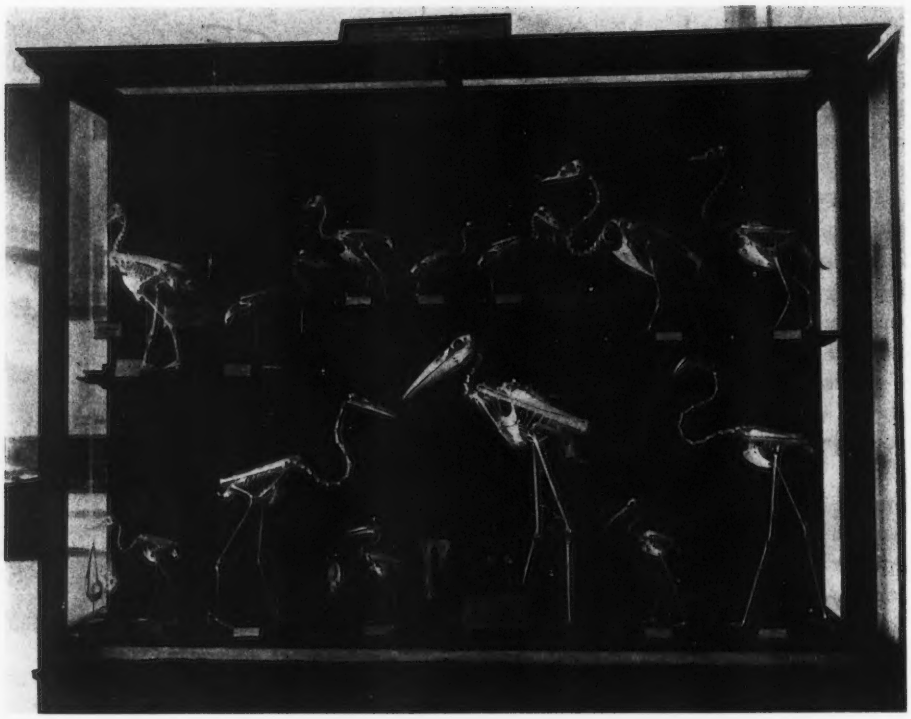


Fig. 5

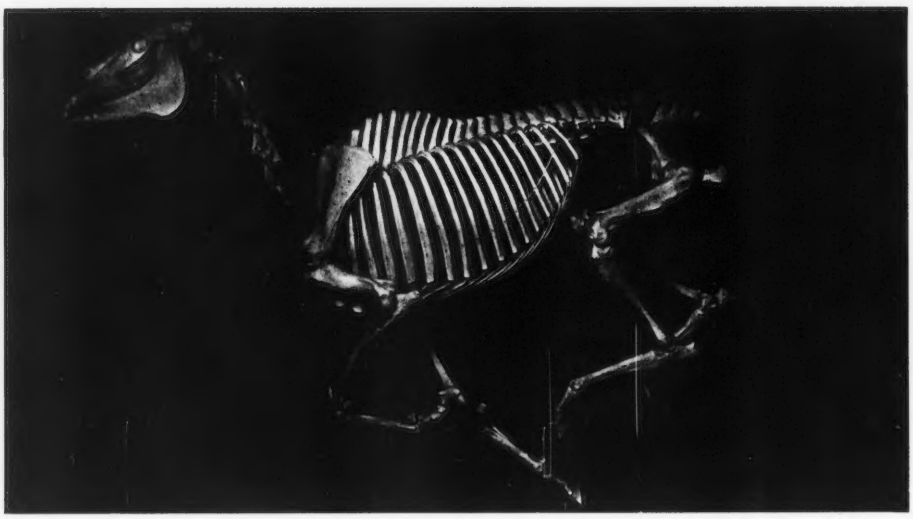


Fig. 6

notion of pairing skeleton with mounted skin in systematic series seems to have had a fairly wide vogue, but can scarcely be said to have created exciting perspectives in our exhibition halls.

At the Naturhistorisches Museum in Basel, K. Rothplets, with the cooperation of the Department of Osteology, undertook the preparation of the skeletons of a wide variety of animal forms in typical action poses. With the support of his institution, he was able to tackle the problem of arrangement for display, as well as the problems of interesting and revealing postures of the individual skeletons. The result is a most attractive exhibit of skeletons of living species in which the pattern of the whole enriches instead of detracting from the visitor's appreciation of each single unit. Without doing full justice to the display, the accompanying Figure 7 may give some inkling of its pleasing qualities.

The skeletons we have discussed so far have been those obtained from the bodies of living species. It has been pointed out that their problems differ in various ways from those of the fossils. The very presence of the living tends to reduce their skeletons to a very minor role in public interest, an unexciting minor detail of contemporary reality, while the fossil remains our one and only clue to exciting mysteries of the past. Probably this is the reason why the competition of the habitat groups could stimulate the museums to a far better and livelier display of their fossil bones at the same time as it very adversely affected their appreciation and treatment of recent skeletons. While the skeletons gathered the dust of the dead, the fossils paradoxically began to take on a new life. The fossil skeleton of an *Allosaurus* feeding upon the fossil remains of a *Brontosaurus* in The American Museum of Natural History is a good example of an imaginative and successful early restoration (see Fig. 8).

But the success of the habitat group in presenting contemporary life in nature with an illusion of complete reality has imbued all disciplines of natural history with an ambition to do likewise. When the fossil preserves or adequately demonstrates the external appearance of the beast, the paleontologist also has a good chance of succeeding by the method of realistic reconstruction of habitat. Among the best examples are the carboniferous forests with their giant insects seen in various museums. Fossil invertebrates generally seem to lend themselves well to life-like presentation, and scenes from the acquatic invertebrate life of remote

Fig. 5. Relatively pleasing traditional arrangement of bird skeletons in the Smithsonian Institution.

Fig. 6. Running horse skeleton by S. H. Chubb, in The American Museum of Natural History.

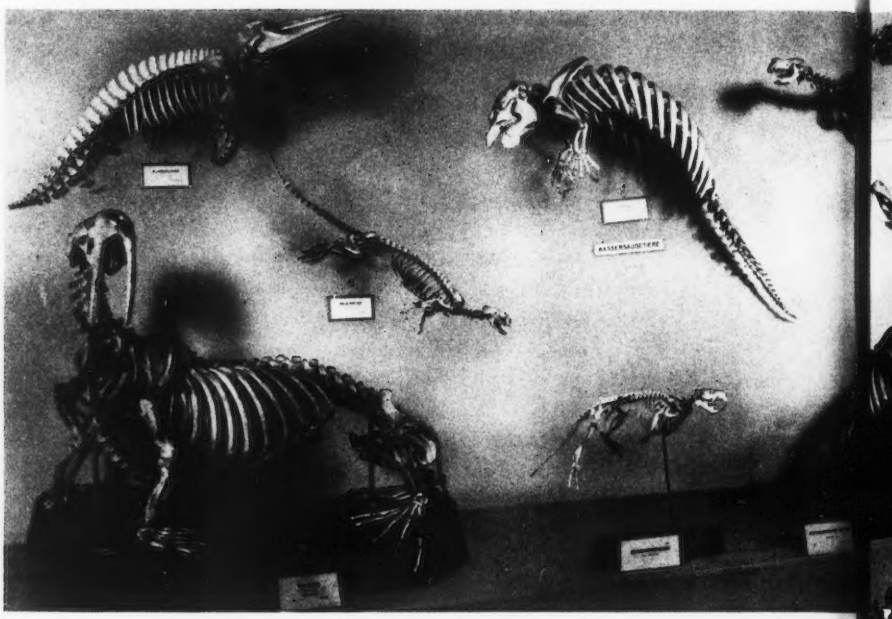


Fig. 7

Fig. 7. Aquatic mammal skeletons by K. Rothplets in Naturhistorisches Museum in Basel.

Fig. 8. Skeleton of Allosaurus *feeding upon skeletal parts of* Brontosaurus. *The American Museum of Natural History.*

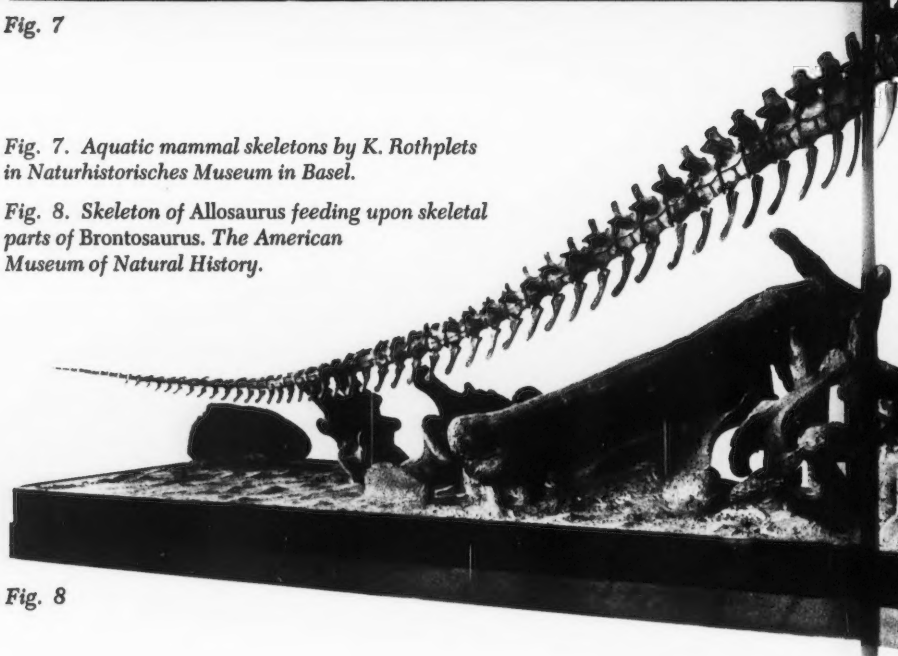
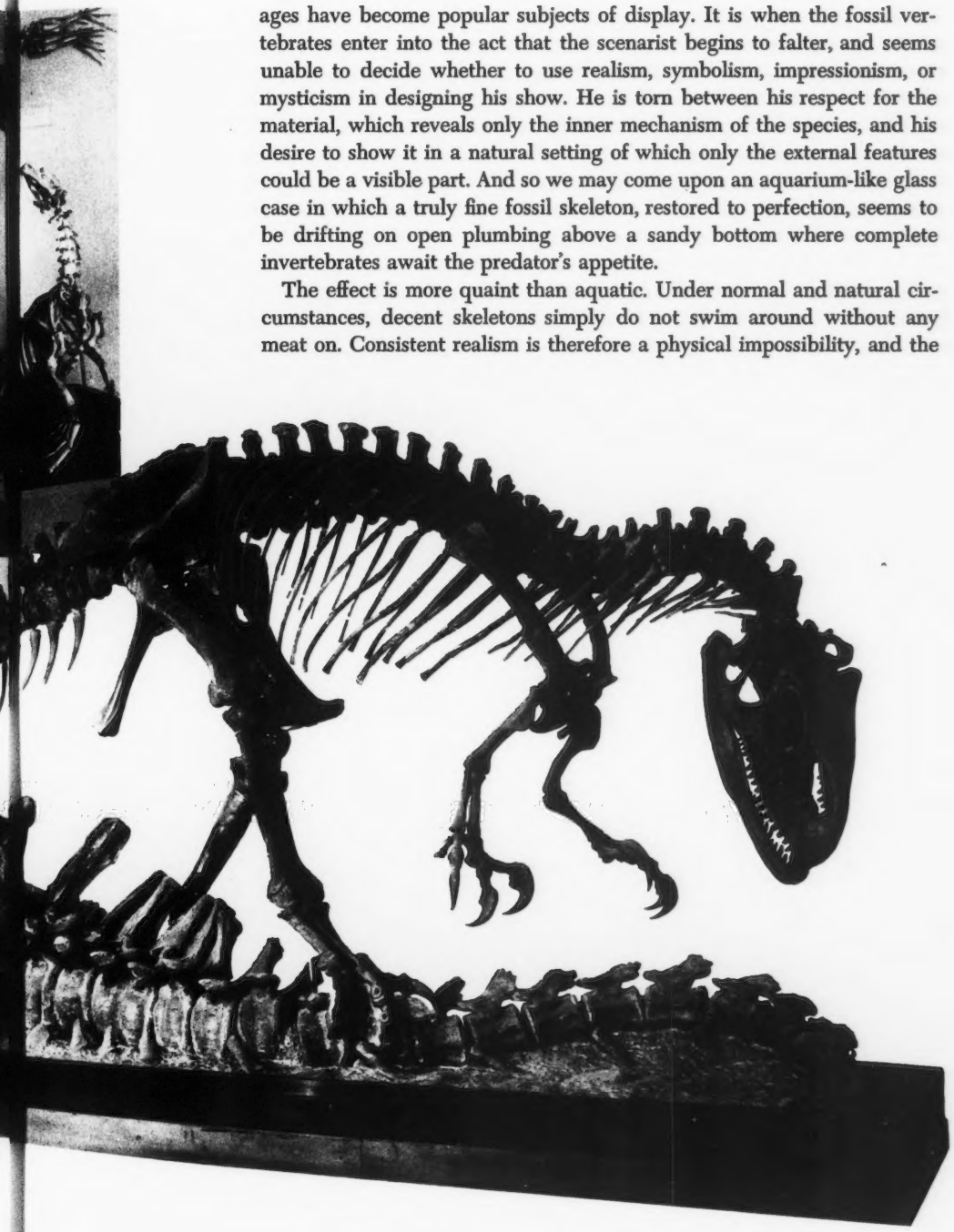


Fig. 8

ages have become popular subjects of display. It is when the fossil vertebrates enter into the act that the scenarist begins to falter, and seems unable to decide whether to use realism, symbolism, impressionism, or mysticism in designing his show. He is torn between his respect for the material, which reveals only the inner mechanism of the species, and his desire to show it in a natural setting of which only the external features could be a visible part. And so we may come upon an aquarium-like glass case in which a truly fine fossil skeleton, restored to perfection, seems to be drifting on open plumbing above a sandy bottom where complete invertebrates await the predator's appetite.

The effect is more quaint than aquatic. Under normal and natural circumstances, decent skeletons simply do not swim around without any meat on. Consistent realism is therefore a physical impossibility, and the



desperate effort to achieve the impossible takes on a slightly hysterical note.

The old installation of giant sloths in The American Museum of Natural History may serve as another example of realism attempted, but not achieved, and therefore slightly disturbing (see Fig. 9). It is the writer's opinion that it was particularly the simulated tree trunk that seemed much too solid for mere skeletons to contend with. Whatever the explanation, there was definitely something that did not seem right about this exhibit. Reactions so far indicate a far more pleased and interested public response to the reinstallation of the same fossil skeletons against a ghost-like background landscape in white on black, and without aggressively real three-dimensional accessories, as shown in Figure 10.

One principle stands out very clearly from the comparisons already made. If the primary object around which an exhibit is organized is only capable of suggesting, then the secondary specimens and artifacts used as accessories must not be permitted to assert themselves in a more explicit manner. Skeleton feeding on skeleton or skeleton leading a skeleton is all right. But man leading skeleton, or *vice versa*, would be more ridiculous than educational. When inherent dissimilarities in the nature of various parts of an ensemble make it impossible to present them all in the same manner, the form of presentation of the secondary elements must be less explicit than that of the principal objects. Plants and trees have no counterpart for the vertebrate skeleton to ease the dilemma of the exhibitor. Even the most conventionalized models of vegetation in solid, three-dimensional form create a rather incongruous setting for gamboling skeletons, but a ghost-like landscape barely suggested in the darkness of the background may add information, depth, and esthetic quality to the display.

A beautifully simple application of the principle of effective suggestion, rather than attempted realistic illusion, may be seen in a recent installation at the Museum of Comparative Zoölogy at Harvard College. Disdaining any pretense at realism, it succeeds in creating such a strong and self-evident suggestion of an aquatic existence that it instantly and automatically registers on the mind of the observer without any conscious ratiocination. The means by which this is accomplished are so simple that they seem to offer little to talk about. But the slight difference be-

Fig. 9. Old installation of Giant Sloth skeletons in The American Museum of Natural History.

Fig. 10. New installation of Giant Sloth skeletons in The American Museum of Natural History.

Fig. 9

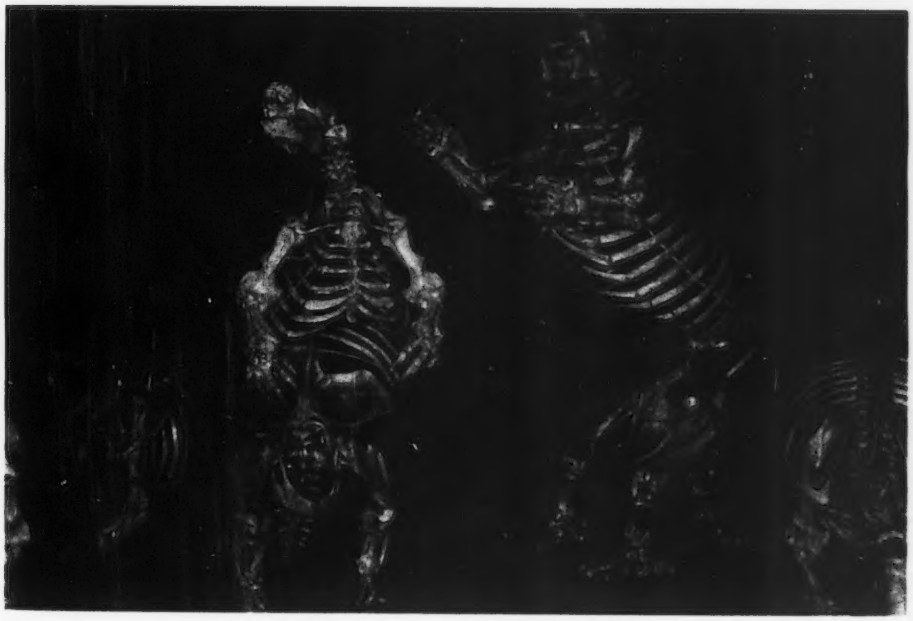


Fig. 10

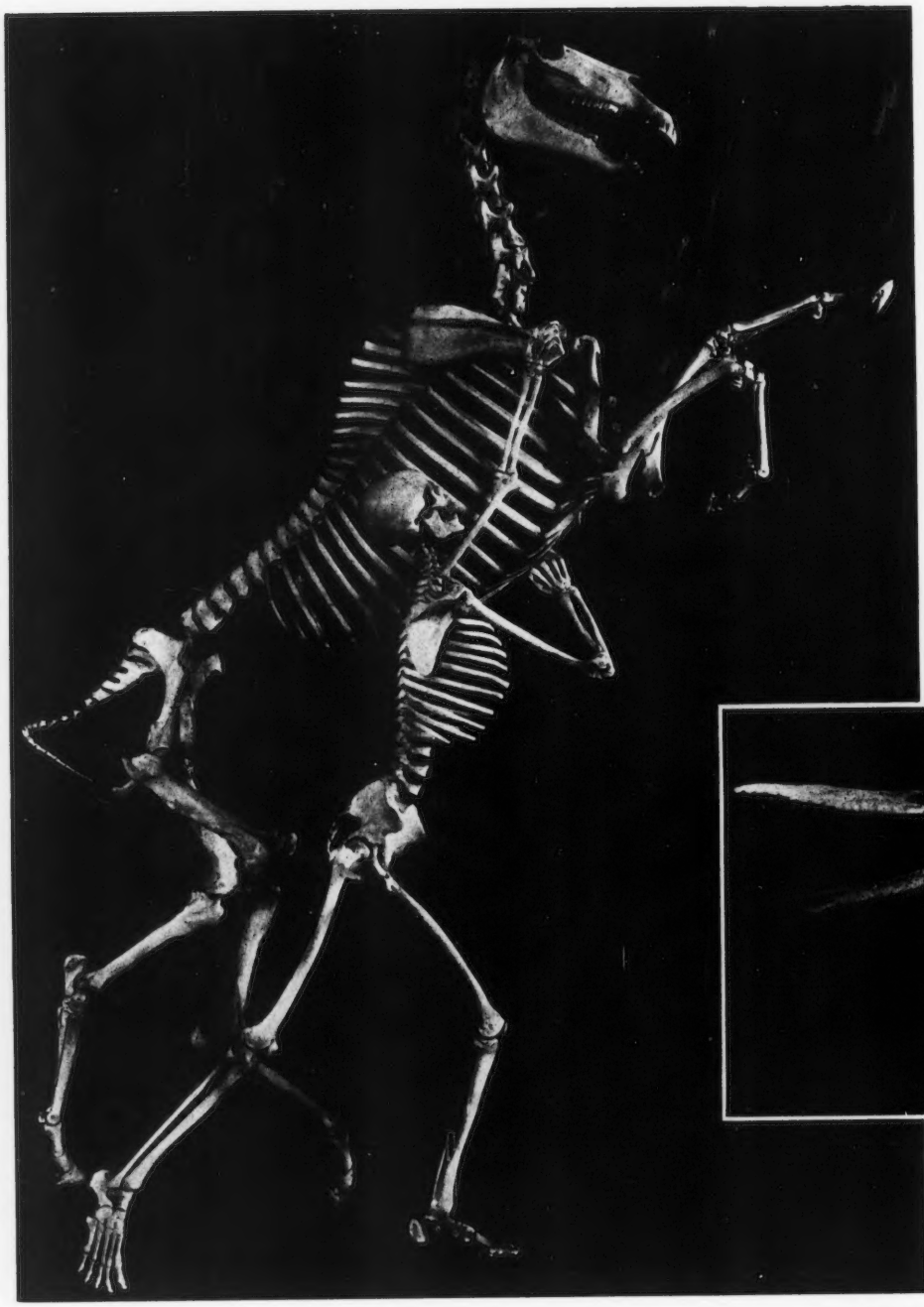


Fig. 11

tween a hit and a miss always deserves our attention. The exhibit consists of virtually nothing but a beautifully preserved fossil skeleton of the giant aquatic reptile *Kronosaurus*, installed in a half tunnel with the off side of the skeleton partly buried in the watery blue of the plaster matrix from which the specimen seems to emerge into view before the visitor, between thicknesses of the same solid blue above and below. The fact that this arrangement permits the concealment of nearly all the usual means of support further strengthens the suggestion of a free-floating existence conveyed by this very attractive, but far from liquid-looking display. While the exhibit cannot make us *think* we are seeing an animal moving through the water, it does make us *feel* very clearly that if this is not what we are looking at, it certainly ought to be. And so suggestion succeeds where illusion would fail.

Perhaps, therefore, the new exhibit at the Museum of Comparative Zoölogy is not merely solving the special problem of its own material but is also pointing towards new solutions for other problems we thought we had already solved by imperfect illusion rather than perfect suggestion, according to heretofore hallowed concepts of rules of propriety in scientific museum exhibition.

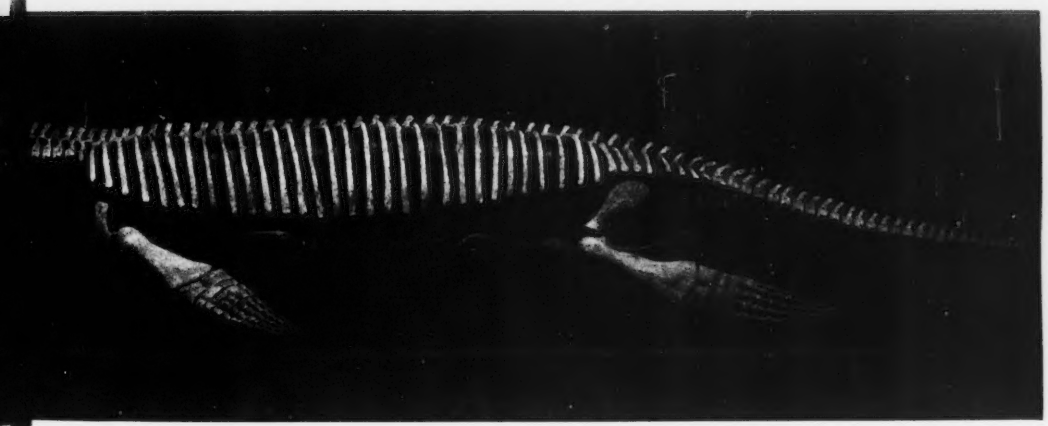


Fig. 12

Fig. 11. Skeleton of man leading skeleton of horse, by S. H. Chubb. The American Museum of Natural History.

Fig. 12. Kronosaurus *in the Museum of Comparative Zoölogy at Harvard.*

The Role of the Research Museum in Science

Introduction

ALBERT C. SMITH, DIRECTOR
MUSEUM OF NATURAL HISTORY
SMITHSONIAN INSTITUTION

There are probably as many definitions of the word "museum" as there are museums, for no two of these institutions seem to be alike. Perhaps a consensus, however, would show that most people agree with one of Webster's definitions. According to this, a museum is "a building, or part of one, in which are preserved and exhibited objects of permanent interest in one or more of the arts and sciences." That is to say, the concept of exhibition seems to be emphasized in the standard definition of a museum. But I would remind you that the quoted definition is the third in the dictionary. Webster's second definition describes a museum as "a house or room devoted to the cultivation of letters or learning." You see, here there is not a word about exhibition, education, or information. I hasten to add that Webster considers this definition obsolete. This is fortunate for the American Association of Museums, the staff of which will not have to investigate the qualifications for membership of every "house or room devoted to the cultivation of letters or learning." But let us look at Webster's first definition, prefaced by the words "Greek Antiq.": "a place sacred to the Muses; specifically, the great institution for literary and scientific studies built and equipped by Ptolemy I at Alexandria, which was virtually a university of the Hellenistic world." Originally, therefore, the concept of a museum was identified with that of a university. It was a place for research, study, and contemplation.

No museum can be everything, but we will all admit that among its present-day functions it may serve as a center for education, a center for pleasure and recreation, a center for information, a center for documenta-

(EDITOR'S NOTE: Symposium at the Fifty-fifth Annual Meeting of the American Association of Museums in Boston, May 27, 1960, presented at the Science Section.)

tion, or a center for research. In the present symposium we discuss principally the classical museum function: to serve as a center for research, study, and contemplation. Such a center is truly a museum, even though is has no function in pleasure and recreation (except for its staff), public education, information, or even documentation. In the field of science, however, research in nearly any area implies documentation. But I would remind you that a collection of meteorites, or a collection of plants, or a collection of ploughs, whether or not they are ever seen by the public, all still constitute museums, as long as they provide a basis for study and research.

Most research museums in the field of science, of course, do serve some of the other usually implied museum functions. In addition to providing essential documentation of scientific conclusions, they frequently incorporate educational facilities at some level, and they may or may not be attached to an institution concerned with public exhibition. But I believe that my co-authors do not emphasize the function of the science museum in the areas of exhibition or public education, however sympathetic we all may be with these functions.

I have been remarkably fortunate in inducing four distinguished museum scientists to discuss the role of the research museum in science. Each is a widely renowned specialist in his own field, and the fields are representative of much of science, embracing biology, geology, anthropology, and the history of science. How certain aspects of these fields of science depend upon the research museum will be the basic theme. But another facet of the research museum that concerns us all deals with the continuing development of such centers, their acceptance by our fellow scientists and the general public, and their financial support. The future financial picture of research museums, not to mention the present financial picture, is not always bright. Continuing and expanding financial support for science concerns everyone in the world, whether he knows it or not, and we think that research museums have a definite and important place in the future of science. Science museums receive their funds from three principal sources, or from a combination of these sources: private endowments, universities and other schools, and taxes at the federal, state, or local level. Our authors represent museums that obtain support from all these sources, and they express their ideas as to trends and future goals in practical matters of support in the various types of research museums.

III/4 1960

The University Museum and Biological Research

HUGO G. RODECK, DIRECTOR
UNIVERSITY OF COLORADO MUSEUM

The museum is not quite yet a clearly defined unit in our culture, and its position on a campus among the other more conventional activities of a university is perhaps even less well agreed upon.

A documentation of the contributions of museums to research in biological science would be a tedious repetition of what everybody knows. The volume of research publication which has emerged from the great museums of the world rivals that of the universities, and in systematic areas may exceed it. This is a converse statement of the fact that systematic research depends upon the availability of extensive, representative collections.

The museum as an institution bears a startling resemblance to the university as an institution. Both are dedicated to professional and general education, based upon the exercise of scholarship and upon the urge to inquiry and the increase of human knowledge. The museum is an indispensable agent of these objectives when the knowledge sought is of tangible things, because in such studies our intellectual constructions become empty if they are not continuously tested against the realities with which they are concerned.

Museums are fundamentally collections. The research that naturally results from the study of collections is systematic and normally leads to the formulation of taxonomic systems. The need for systematic understanding and for taxonomic systems is basic to any biological investigation that requires a statement regarding the organism being referred to or discrimination between any one organism and any other. One of our writers in theoretical museology once said, in speaking of museum-based studies in universities, that "Museum collecting usually brings in extensive systematic collections; and the related museum research in zoology and

botany leans toward producing systematists rather than experimental biologists" (Coleman, 1939). He then goes on to refer to *"this difficulty"* (italics mine). This is obviously (though perhaps it is subconscious) an example of the depreciation of systematics that has characterized recent decades. The remark was recorded at a time when it did indeed seem that all necessary systematic work had been completed and that the future of biology lay entirely in the experimental laboratory.

What Coleman might have said was that the museum, though similar in its general objectives and methods to the university, lacks the universality of the latter and properly restricts itself to those subjects that are concerned with our knowledge of tangible things which can be collected, studied, dissected, analyzed, classified, named, and preserved for subsequent reëxamination as a control on our classificatory and nomenclatorial structures. It is no more unfortunate that museum studies tend to be systematic in their nature than that people should tend to ride in automobiles. Such is their function.

As for the need for such activities, a very recent commentator has said that "a handful of taxonomists are trying to do a job for which there should be ten times as many workers" (Oman, 1960). General observers, and even general biologists themselves, have become convinced of the decline of the status of systematics, which has been furthered by the failure of systematists to insist upon the basic nature of their activities. No one who has not engaged in systematic studies can understand, as it has recently been put, "how a job that has been under way for more than 200 years can still be largely unfinished" (Oman, 1960).

Perhaps it is not necessary in this period of interdisciplinary cooperation and increasing appreciation of the essential unity of the world (which has been so extensively subdivided into discrete intellectual disciplines as to obscure the fact that these are only convenient, artificial, philosophical devices) to insist upon the fundamental and indispensable need for systematists in all fields of biology. Every thoughtful analysis of the present situation in the biological sciences ultimately comes around to a consideration of (1) the difficulty of getting biological materials indentified authoritatively, and (2) the absolute requirement that they must be so identified if the conclusions to be reached are to be significant or even understandable.

A very recent symposium on the present and future status of systematic biology (Kellogg and others, 1959) quotes startling figures on the probable proportion of plant and animal species that are still unknown, and the equally startling fact that even for economically important groups we often have no available source of printed information and only a few specialists at work or none at all. Those whose profession is the classification and identification of plants and animals are so overburdened with

demands on their services that they must set up procedural controls to restrain the biologists who need their opinions.

In a science in which we are so personally concerned, not only being organisms ourselves but depending upon other organisms for our very existence, such a manpower shortage is one to which our universities could well pay attention. A few recently passed decades saw a discernible shift in university biology departments from the so-called "old fashioned" systematic and morphological approach to the generally termed "modern" functional and ecological approach. Increased emphasis on a more dynamic viewpoint was justified enough, but the pendulum swung so far as to bring systematics and taxonomy into actual disrepute, as if these were things which no longer required to be done and as if the people who continued to do them were describing slow circles in an intellectual backwater.

Another recent commentator on the situation in entomology, one of the fields in which the problem is the most serious, has observed:

> The heart of any systematic effort is the museum. We need greater support here. All of our so-called great museums are grossly understaffed and, what is more, relatively understaffed entomologically. A single man in one devoted lifetime can amass in a given order as large a collection as is present in any of our museums. I know this to be true for I have seen it done. Yet, there seems little agitation on the part of the general entomologist to try to improve this condition, or even to make the directors of museums and the general public aware of the enormity of the existing discrepancies (Slater, 1960).

By the time a university student is approaching his terminal university degree his scientific interests and attitudes have been pretty largely determined. If we are to stimulate a revival and nourish a continuation of systematic biological work, for its own sake as well as for those other interests for which it is the indispensable tool, we shall have to provide at least some of our universities with the extensive systematic collections that are requisite for critical systematic investigations. Such large collections require museums for their assembly, their augmentation, and their preservation.

Perhaps the indefinite multiplication of such institutions should not be advocated. Perhaps those that are already established, or those in which a beginning has been made, are numerous enough and sufficiently well distributed to furnish regional centers where systematic biological studies can be carried on among collections large enough to furnish a truly professional experience. Possibly the other universities and the colleges of each area could leave to the systematic center the task of training systematists and that of the identification of the organisms concerned in their own biological research. Perhaps they may more readily be persuaded

to do so if they realize that there is a minimum size below which a collection can be no more than a tantalizing incitement to systematic study and inadequate to furnish the size of sample necessary to constitute a valid model of the actual phenomenon as it exists in nature.

On a campus where extensive collections of biological materials (or any other kind of materials, for that matter) are sheltered, the exhibition of them for one purpose or another is virtually inevitable. Traditionally, series of specimens are sooner or later exposed by the use of glass-fronted storage cases for examination by major students as a part of their required course work. Inevitably other students see them, whether by accident, interest, or perhaps by the morbid fascination of certain kinds of biological specimens. Willy-nilly, an involuntary public museum program may be launched which, because of faulty aim or, more usually, lack of aim, may fall to earth in some undesired place. Non-professional students who happen upon the "exhibits" may conceive of biology as the science of pressed hay, pickled snakes, and discolored animal organs and thus not only perpetuate an already widespread student misconception but offer visual demonstration of its literal truth.

In the interests of systematic recruitment it may be more desirable deliberately to present to the general university student body as attractive and stimulating a picture of the infinite variety of nature as possible. Such a plan suggests a positive exhibition program for any university collection, with the utilizing of all the cunning devices that modern museology can bring to bear. This program should be deliberately aimed at a dual purpose, the two objectives of which are not really very different. One of these is the stimulation of interest among biology majors in vocational systematics, accomplished, at least in part, by presenting taxonomic distinctions as interesting and significant. If avocational bird watchers can become absorbed by the distinctions between closely related warblers, and gardeners between nearly identical strains of flowers, we may be permitted to depend on the fact that a percentage of our young people will be inclined towards making such distinctions, and to enlist some of them for this essential scientific work by presenting the possibilities to them in an attractive form. At the same time the general student group may, by observing the systematic point of view attractively and provocatively presented, thereby be persuaded to an improved social attitude towards this often obscure but very essential scientific field.

REFERENCES

Coleman, Laurence Vail: *The Museum in America, a Critical Study.* Washington, vol. 1, pp. 170–171. 1939.

Kellogg, Remington, F. A. Stafleu, R. E. Blackwelder, David D. Keck, and G. W. Wharton: *Symposium: Systematics, Present and Future.* Syst. Zool., vol.

8, no. 2, pp. 59–87. 1959.
Oman, P. W.: *The Relation of Insect Taxonomy to Applied Biology.* Bull. Ent. Soc. Amer., vol. 6, no. 1, pp. 3–5. 1960.
Slater, James A.: *The Responsibilities of the Insect Taxonomist.* Bull. Ent. Soc. Amer., vol. 6, no. 1, pp. 17–19. 1960.

The Museum and Geological Research

EDWIN H. COLBERT, CHAIRMAN
DEPARTMENT OF VERTEBRATE PALEONTOLOGY
THE AMERICAN MUSEUM OF NATURAL HISTORY

The original *Museum,* the Temple of the Muses at Alexandria, one of the greatest accomplishments of classical antiquity, was not a museum as we think of such institutions, but rather a group of schools and research institutes in the fields of literature, mathematics, astronomy, and medicine, with a magnificent conjoined library. It was, in effect, a sort of university. The museum as we know the museum had its beginnings in Europe in the sixteenth century, during the reawakening of scientific inquiry that followed the dormancy of medievalism in the western world. It arose from the private "cabinet" of the nobleman, to pass through various metamorphoses until, by the end of the seventeenth century, museums that were the direct ancestors of our modern institutions had taken form.

When the concept of the modern museum was still in its formative stage, the importance of museum research was already clearly recognized. Furthermore, this early recognition of the role of research in the museum made special mention of geological materials. Such recognition was accorded by Robert Hooke, one of the great figures in seventeenth century science and Curator of the Repository of the Royal Society, who made

the following very perceptive remarks, which almost in modern terms outlined the central position of research in the museum:

> It were therefore much to be wisht for and indeavoured that there might be made and kept in some Repository as full and compleat a collection of all varieties of Natural bodies as could be obtained, where an inquirer might be able to have recourse, where he might peruse, and turn over, and spell, and read the book of nature. . . The use of such a collection is not for divertisement, and wonder, and gazing, as 'tis for the most part thought and esteemed, and like pictures for children to admire and be pleased with, but for the most serious and diligent study of the most able proficient in natural philosophy. And upon this occasion tho' it be a digression, I could heartily wish that a collection were made in this repository of as many varieties as could be produced of these kinds of fossile-shells and petrifactions, which would be no very difficult matter to be done if anyone made it his care (Edwards, 1931).

It is not the purpose of this article to trace the growth of our museums from their beginnings in the seventeenth century, nor to follow the development and the refinements of research, especially geological research, in the expanding museums of the eighteenth and nineteenth centuries. It need only be said that the concept of the museum as a research center continued through the years, even though in many instances this important principle was almost forgotten in the excitement of new discoveries, new buildings, and new displays. But the germ of the idea was never completely lost, and it is gratifying to us as Americans to see that the first real museum to be founded on our continent was a natural history institution, so planned that original studies would be the basic and primary function of its activities. This was the Museum of the Library Society of Charleston, South Carolina, established in 1773.

The active and public-spirited gentlemen who created the Society and its accompanying Museum developed a plan whereby "all the natural Productions, either Animal, Vegetable, or Mineral" to be found in the province of South Carolina would be deposited in the museum for classification and study. The thought behind this plan was to develop for the Province a "full and accurate Natural History of the same."

With this brief glance at the function of research, and particularly research in geology, within the museum, as envisaged by one of the founders and some of the early supporters of the modern museum, let us now turn to the situation as it exists today—the result not only of two centuries of growth but also of the tremendous burgeoning of all the sciences within the past few decades. What place does geological research occupy in the present-day museum? How is this research to be equated and integrated with research outside the museum, specifically as carried on in universities and research institutes? What is to be the future of geological research within the museum?

In the first place, it may be well to have a clear understanding of the scope of geological research in the museum, and this is necessarily dependent upon the very nature of the museum as it exists in the modern world. Because the twentieth-century museum has its being in a rapidly changing world, its archival function is a primary one. It is a place for the preservation of *objects*. It is an institution that through long years of trial and error has developed techniques and methods for the acquisition, cataloguing, and keeping of things, so that they will be held safely for an indefinite time into the future, complete with data as to where they came from, how they were acquired, and so on. It seems to the present writer that all museum programs and activities should logically be centered around this basic museum function.

Yet the archival function is not the only basic museum activity. To our present manner of regarding the problem, an institution that merely houses specimens or articles is not a museum—it is a warehouse. Study and interpretation are as important to the modern museum as the archival function, and it is the combination of these activities that makes the museum a force in our culture. Collections and the interpretation of these collections complement each other to make the museum; they are necessarily as important to each other as the two components of a binary star, each revolving around the other in a pattern of mutual gravitational attraction. As for the display of the objects that are housed and studied in the museum, this is a desirable but not a basic museum function, even though a large segment of the public and a considerable portion of professional museum people seem to think that such is a primary museum aim. A socially conscious museum usually does display its treasures to the best of its ability, but in some circumstances display is not necessary or desirable, as in the case of some university research museums.

This discussion may seem to be a distracting interpolation, but it is included here to point up the very important problem of what should be included within the limits of museum research and, in the present instance, of geological research in a museum. If the premise of the preservation of objects is admitted as a basic museum function, then geological research in a museum is almost of necessity centered on the fields of mineralogy and paleontology. These geological disciplines are mainly concerned with things dug out of the ground, a fact to which the development of geology in museums all over the world attests. In almost all cases geological research in museums is research on minerals and rocks and fossils.

Conceivably, geological research in museums might extend beyond the fields that have been mentioned—to the study of sediments, for example. There is no reason why a museum might not have a curator of sedimentation, who would collect samples of sediments from various localities,

study them and publish papers about them, and house them in jars or cans or boxes on shelves in a storage room. But such certainly has not been a common museum practice, and the extending of primary museum studies in geology to such fields as earth structures or land forms (geomorphology) seems to be getting rather beyond the proper field of general museum practice. One does not collect and curate mountains or canyons, although there is no reason why studies of mountains and canyons should not be made as adjuncts to the research in geology that is usually carried on within a museum. In this connection, it should be made clear that nothing prevents a museum from setting out displays that cover the entire spectrum of geology—and a very broad spectrum it is—but if a museum attempts to cover this wide field of knowledge in its research program it will depart very far indeed from the basic functions of a museum, to become a research institute. All of which brings us back to our main point—that the value of a museum is to a considerable degree based on its organization for the taking care of objects.

The necessity of having organized care of collections has been demonstrated time and again, and often quite painfully, by those universities or colleges that have no museum facilities. Some professor carries on a research program that involves the collecting of fossils or minerals. He studies his specimens and publishes valuable papers about them. Then, because there are no formal procedures for taking care of the specimens, they are scattered and not infrequently lost. Subsequently posterity suffers, because more often than not no check on the validity of the scholar's published works, which may include very basic data or very important principles, is possible because there is no recourse to the original materials. The writer can think of a very good case in point, involving a particularly important fossil reptile skull and jaw. It was described by a paleontologist in one of our foremost universities, but that particular institution did not have proper museum facilities. The specimen is now irretrievably lost (how is such a large fossil lost?), and as a result there is no sure way of checking the basic taxonomic relationships in one group of extinct reptiles.

With these various considerations in mind we can now turn to an examination of the nature of geological research in the museum, and here we see a progression, a development through time that has gone hand in hand with the changing growth of museums as institutions. In the early days of museums the primary function of research, geological research included, was the identification and classification of materials that were sent in to the museum by interested friends. The original minutes that set forth the establishment of the Museum of the Charleston Library Society, alluded to in an earlier paragraph of this present paper, nicely illustrate this function:

> That this may be done [that is, to gather materials for the natural history of South Carolina] in the most complete and extensive Manner, *they* [the founders] *do now invite* every Gentleman who wishes well to the Undertaking . . . to procure and send to them, all the natural productions, either Animal, Vegetable, or Mineral, that can be had in their several Bounds, with Accounts of the various Soils, Rivers, Waters, Springs, &. and the most remarkable Appearances of the different Parts of the County.
>
> They would be glad to be furnished also with the Specimens of all the various Fossils, Minerals, and Ores, the different Soils, Earths, Clays, Marles, Stones, Sands, Shells, &. the Productions of this Province, with the best Accounts of their several Natures, Qualities, Situations and Uses (Smallwood, 1941).

By being the repository for things sent in by cooperative travelers and landowners, the early museums grew, and some of them grew mightily. The British Museum is a prime example, because it had not only the resources of a great empire available as the wellspring of its treasures, but also the help of numerous loyal citizens who literally scoured the corners of the earth to bring back rare and curious objects to enhance its collections. Much of the growth of British Museum collections took place in just this way.

So it was that the curator was a "keeper" (which is still the title of such functionaries at the British Museum) who cared for the specimens in a very literal sense. He accessioned the objects that came to him, identified them, and put them away in drawers or on shelves. If he had time, he perhaps wrote descriptions of the more noteworthy specimens, to be published in the Museum catalogues or in other sources. In time the curator became more than a mere keeper. He became a research scientist of the first order who not only described the materials that came into the museum, but also initiated well-designed programs of research, such programs frequently including extensive field explorations as a part of their initial phases. Today the research programs in first-class museums are well considered and well integrated; they are planned as long-range projects and so far as possible are carried forward as logical rather than as opportunistic undertakings.

Modern geological research in museums therefore commonly involves carefully planned field trips, during the course of which the specimens are collected, with strict attention being given to localities, stratigraphic relationships, and other geological phenomena that may bear upon the problem at hand. Such field trips and collections generally are made to fill definite needs and not merely because Mr. Smith, a rancher, has found some fossils on his land. Not infrequently the curator may go into the field with no intention of making collections at all. He may need to perfect his knowledge of an area from which collections already have been made,

so his expedition is a "study trip" to give him additional background for a proper intepretation of the fossils or the minerals with which at the time he may be working.

In the museum laboratory geological research has gone beyond the simple descriptive stages that characterized so much of it during earlier years. Of course much description is still done, and will be done in the future; new species of minerals are always coming to light; and new genera and species of fossils are constantly being found, these every now and then representing new categories of higher taxonomic value, hitherto unknown in the fossil record. It is highly important that all these new things be described as expertly as possible, and with convenient dispatch. But beyond this there is still much additional work to be done on museum collections, work that adds great breadth and depth to our knowledge of minerals and rocks and fossils.

Research on minerals in museums is of particular value because of the large, available collections of comparative materials. Such collections are of special significance in systematic studies, and they enable the student to investigate the nature of minerals on a broad front. Work is carried forward by various methods, by geochemical analyses and by X-ray studies, as well as by other modern refined techniques.

As for fossils, here again the particular value of a museum is in its large collections, which allow for extensive comparisons. Such collections are of inestimable value not only for the more routine systematic studies, but also for the extensive investigations carried forward along various lines intended to throw light from different angles, as it were, on the fossils and on the data to be obtained from them. Thus research on fossil collections may be concerned with population analyses or statistical studies, in which case large collections are of prime importance. Or it may be concerned with stratigraphic relationships of fossils. Or it may have to do with anatomical and physiological problems, in which case the paleontologist may be led far afield—to the study of related modern animals, for example.

Thus it can truly be said that geological research in the modern museum has many colors and many facets. This means in turn that considerable quantities of equipment and of facilities along other lines are necessary for successful work by the museum geologist. Gone are the days of a pick and hammer and a hand lens, and little else.

Today the museum geologist goes into the field with special field cars, more often than not loaded with a varied array of equipment for excavating. Of course there are the usual hand tools that have been used for generations, but in addition there may be portable machine drills and hoists. There may be Geiger counters and ultra-violet lights. There may be specially constructed boxes for washing fossils out of sediments—

a technique that is becoming extraordinarily useful for the recovery of very small fossil materials. And naturally there is the usual camping gear —with modern refinements.

In the preparation laboratories there are still other aids for the skilled and patient hand. Acid is being widely used for the dissolving of matrix around fossils. This requires large, specially constructed tanks; in fact many museums now have separate acid rooms, furnished not only with tanks but with sinks for washing, with hoods and fans for the exhalation of fumes, with overhead trolleys for the lifting and moving of large blocks of rocks, and with other necessary equipment. As for the mechanical preparation of fossils, new aids have been developed within the past few years in the form of high-speed drills and grinding wheels—the Cavitron (a supersonic instrument that delivers some thirty thousand pulsations per second for the reduction of hard and recalcitrant matrix) and the Airdent (a carbon dioxide blast used with aluminum oxide and powdered dolomite as abrasives for the removal of matrix from extremely fragile specimens). Minerals and rocks must frequently be cut with diamond saws, and the cut surfaces polished by the use of laps. The tried and true methods of making slides for the microscope are still much in use.

In the illustrator's room, which is very much a part of museum geological research, many aids also are needed to assist the artist in delineating specimens, especially fossils, for published illustrations. (The necessity for adequate facilities for illustrating fossils is sometimes overlooked by the museum geologist and often ignored by the administration in a museum.) There need to be good camera lucidas and pantographs, good modern optical instruments, and good photographic equipment with the accompanying darkroom facilities.

In the research laboratories additional expensive equipment is necessary for modern research on minerals and fossils, particularly geochemical apparatus and X-ray equipment, various types of microscopes, computing machines, calipers, and other devices, often specially developed for particular purposes. There is no need to prolong the consideration of the various items of preparation and research aids or to labor the point that geological research in the museum costs money, just as does all modern research. It is a part of the price we pay for our advancement to a highly specialized science in a culture of specializations.

One thing that should be especially emphasized is the importance of the library to the museum geologist. Today it is difficult, frequently impossible, to attempt serious research in a museum without a specialized library. The library is in a manner of speaking the heart of a modern museum, just as it is of the research institute or university. The paleontologist or mineralogist who lacks the publications he needs can be a very frustrated individual.

Collections are necessary, proper equipment for collecting, preparation, and research is crucial, and a good library is essential, if a man is to do geological research in a museum today. But above all there is the man himself. If a museum is to maintain its position as a leading institution of its kind it can do so only by having a good staff of authorities as the hard core of the institution. In a natural history museum everything—administration, maintenance, exhibition, and education—revolves around the scientific staff. An enlightened policy should see to it that the institution has outstanding men as members of the scientific staff, and that these men be given the opportunity to carry on their research without excessive interference, certainly without undue or complete interference because of routine duties. The right of the museum scientist to do research is the proper price the institution must pay in order to have men who speak with authority, not only through their own scientific publications but also through the media of exhibits, teaching programs, and general public relations. A curator should be equal in rank and status to the university professor and should receive a salary commensurate with this rank. In addition to the help from mechanical and optical equipment, he should have human assistance as well—preparators, scientific assistants, illustrators, and secretaries. The curatorial position involves more than a single person in a modern museum.

These varied thoughts, some of which are not limited but nevertheless are very pertinent to the problem of geological research in the museum, bring us to a comparison of the endowed with the tax-supported museum. What have been, what are, and what will be the advantages and the disadvantages for the man who wishes to do geological research, specifically studies on minerals or on fossils, in the various types of museums?

Let us consider first the endowed museum, whether it be a large, independent institution such as The American Museum of Natural History or the Chicago Natural History Museum, or a museum in one of the endowed universities such as Harvard or Yale. The geologist as a member of the scientific staff in such a museum is usually happily independent so far as his research program is concerned. He is free to work on the problems that interest him, provided of course that he is furnished with the support and funds to make his collections and prepare them for study. His program of research can be flexible, and the feeling of freedom that comes from such a situation is very encouraging to the production of original, significant work. But the geological worker in the endowed institution also suffers because of his independence. The endowed institution has no "official" connections; it travels solely on its reputation. It depends on the cooperative help, so necessary for the proper functioning of a museum, that gravitates to it because of its standing and because of the interest of people, both officials and private citizens, in its program.

This position of the endowed institution can impose limitations upon it, no matter how great its reputation may be.

The tax-supported museum, either the independent institution such as the United States National Museum or the New York State Museum, or the museum of a state university such as California or Michigan, enjoys the enviable position of being an "official" body. The geologist in such an institution profits very materially because his employer speaks with the voice of governmental authority. Thus the collections made by many government surveys are housed at the National Museum, and of state surveys at state museums, thereby making available to the curators materials from many sources that are beyond the possibilities for the endowed museum. In short, the tax-supported museum very frequently has available governmental resources that go far beyond the walls of the institution. While this is an advantage, it may have some disadvantageous features as well. For example, the curator in a tax-supported museum may not be quite so independent as his colleague in the privately endowed institution, although of course conditions vary from one place to another. It is a fact, however, that the collections in the tax-supported museum tend to be limited in a very general way to the area from which the institution obtains its support, for it is only natural that the voters of a state are interested first in the natural history of that state, and secondly in the broader aspects of the subject. Furthermore, although the subject is painful to mention, commonly the disconcerting specter of politics is in the background of the tax-supported institution. If there is happily no direct political interference, the museum is none the less subject to the ups and downs of income derived from taxation, which is in turn tied to political considerations.

Finally, as to the university museum, whether it be part of an endowed or of a state institution, there are again advantages and disadvantages to be weighed. The geologist in such a museum has the advantages of close contact with an academic department of geology, where in the first-class universities research is being carried forward along a broad geological front. He has the advantages of a large library near at hand. He has the help of student assistants, often very wide-awake and stimulating young people. Very frequently he may teach at undergraduate and graduate levels in his own specialty, and there is nothing quite like teaching to keep the research scientist from becoming so very narrowly specialized that he loses his grasp on the large aspects of his science. Yet again some of these advantages are at the same time disadvantages. All too frequently the university museum geologist has a dual appointment; he teaches in the university and curates in the museum. Some part of his program may consequently suffer, unless a very clear understanding exists between the university department of geology and the museum. In some institutions

there are two separate staffs, one academic and one museum, and almost invariably the museum staff is less well provided for than is the academic staff. Here is where the importance of equating curatorial and professorial positions becomes of paramount importance. As for the student help, the museum curator may have to depend almost entirely upon such assistance. At best, student assistants are transitory, and the curator lacks the continuity of well-trained permanent assistants that is necessary if his preparation and research work are to be carried out in a truly efficient manner.

With the foregoing discussion in mind, some of it generalized and some of it specific to the subject of geology, perhaps we can now look into the future of geological research in the museum. Certainly such research should continue to grow in importance in the years ahead. In an age when so much research is oriented, when so much is done in the form of projects, when so much is done by teams of researchers, there must be maintained some institutions where the research worker is free to continue as an individual working along lines of his own choosing. The museum occupies a fortunate position in being able to offer the opportunity for this type of research, if not to the perfect satisfaction of the individual, at least to a degree beyond that attainable in most other places. The museum with its collections offers a continuity of subject matter that is its particular strength. With modern and refined methods of technique and study, research on collections of minerals and fossils can advance indefinitely into the future, and the museum because of its special organization as an archival institution can preserve the materials of this research for as long a time to come as is foreseeable by us. Thus the museum will continue to develop as it has in the past, as a center for truly basic research, for investigations of the natural sciences that will ever increase our understanding of the world around us.

REFERENCES

Edwards, W. N.: *Guide to an Exhibition Illustrating the Early History of Palaeontology*. London, British Museum (Natural History), p. 56 (quoting Robert Hooke). 1931.

Smallwood, William Martin: *Natural History and the American Mind*. New York, Columbia University Press, pp. 109–110. 1941.

III/4 1960

The Museum and Anthropological Research

WILLIAM N. FENTON, ASSISTANT COMMISSIONER
NEW YORK STATE MUSEUM AND SCIENCE SERVICE

CENTERS OF ANTHROPOLOGICAL INQUIRY

Man's curiosity about his fellow man is ancient. Already by the third century B.C. there had developed in the Hellenistic world scholars such as Herodotus and, later, Strabōn who sought to describe the manners and customs of diverse neighboring peoples. "In ancient times," Sarton tells us, "there was no public education, but there were philosophers, and . . . there were men of science," but . . . "there was hardly . . . a scientific culture" (Sarton, 1959b). Scholars and scientists of the day gravitated to such institutions as there were. The two outstanding institutions of the Alexandrian Renaissance were the Museum and the Library (Sarton, 1959a, vol. 2, p. 28). Whether these were separate institutions or a single establishment is of no consequence, but it is interesting today that both were royal creations and received their entire support from the government.

In its original meaning, "a museum is a temple of the Muses, who were the daughters of Zeus and Mnēmosyne [memory!]." There were nine of these sisters, and they constituted a kind of council of the humanities. Temples of the Muses were situated everywhere in the classical world, but the Museum of Alexandria was the type specimen. Strabōn left this description of it:

> The Museum is also a part of the royal palaces; it has a public walk, an Exedra (a shaded portico having seats for conversation) . . . and a large house, in which is the common mess-hall of the men of learning who all share the Museum. This group of men not only hold property in common, but also have a priest in charge of the Museum, who formerly was appointed by the kings (Sarton, vol. 2, p. 30).

The first museum has been compared with a medieval college, and its nearest modern counterpart is a scientific institute. Research was the program; there is no evidence of formal teaching, or exhibits. As Sarton

says: "The teaching was restricted to the very best kind . . . informally by a teacher to his apprentices." The facility included a library, a dissecting room, and botanical and zoological gardens. Little is known about its administration. The first two Directors were Demetrios of Phaleron, a libertine, and Straton of Lampsacos, a physicist who gave the place its scientific tone. Both were students of Aristotle and were appointed by Ptolemy, the king. The first came as a refugee from Athens, where he had lived high and worn out his welcome; he settled down in Alexandria, but not for long, for it is said that he died of an asp bite in Upper Egypt. Evidently the influence of the Museum on the progress of science was considerable. It is said that the fellows were permitted to undertake and continue investigations in complete freedom, and, as a consequence, great scientists and scholars flocked there.

The Museum of Alexandria endured for seven centuries, yet today it is well-nigh forgotten. It was an institution guided by the policy of attracting the greatest scholars and allowing them freedom to work on problems of their own choice, having as their only purpose to search for the truth. (Sarton, 1959a, vol. 2, p. 34.)

If I have rewritten the history of the museum movement, it is for a conscious purpose. It is because I am firmly convinced that the staff of a museum takes precedence over its collections. I believe that this relationship expresses essentially the character of the research museum where the collections accumulate as a by-product and directly reflect the research interests of scientists. Then as the scientific collections grow and become a resource for research, the museum attracts scientists and it attains stature proportionate to its resources and its publications. Reputations of museums are ephemeral and must be constantly validated. So long as a museum maintains a research program it will hold its staff and its reputation in the scientific community.

Most museums of anthropology began as collections. Research is the added ingredient. Antiquities and ethnographical specimens were represented in the collections of the earliest continuing American museums, Charleston (1773) and Salem (1799), but the latter half of the nineteenth century saw the establishment of the great natural history museums; and the years 1860–1900 have been termed the "museum period" in the history of anthropology, after which the research lead passed to the unversities (Wissler, 1942). Even in Britain, although Oxford's Ashmolean dates from 1683 and the British Museum from 1753, it was not until 1865 that Henry Christy bequeathed his extensive ethnographical collection to the Crown [British Museum, 1910]. Fifteen years earlier, Lewis H. Morgan had made "the first contributions of notable scientific merit . . . to the annual reports of the N. Y. 'State Cabinet of Natural History' . . . upon articles furnished to the Indian Collection." These were the first scientific

publications in ethnography (Morgan, 1850; Clarke, 1923, p. 390; Fenton, 1960b). The newly founded Smithsonian Institution was, in 1857, to acquire the National Cabinet of Curiosities from the Patent Office, and the nation's ethnological collections, which had previously accumulated from official explorations, were soon to be increased by the encouraging of government field officers to collect among Indian tribes (Ewers, 1959).

The first curators of anthropological collections were amateurs, or they were scientists trained in the natural sciences. Professional ethnologists were to await the founding of university museums of archeology and ethnology. Harvard had the first such museum to be established as a scientific department of a university, at the generous insistence of Joseph Peabody and a committee of Boston gentlemen, who agreed to take Peabody's gift on his terms with the hope of attracting private collections (Peabody Museum, Harvard University, 1878, pp. 177–179). It became largely the image of Frederick Ward Putnam (1839–1915) who, being trained in the Agassiz school of independent search for facts, brought into anthropology a respect for data as evidenced by authenticated collections, which meant that the proper place to do research was in the field. Putnam was a great organizer, a founder of university departments, a builder of museums, and a shaper of men. Putnam's men were field collectors and curators. The transition from biological problems and natural history methods to the use of archeological evidence and to studies of material culture was natural enough, and Putnam's boys[1] revolutionized museum methods, inaugurating the exploration for collections instead of purchasing collections for study. Putnam's other institutions—the Field Museum, which grew out of the World's Columbian Exposition, the anthropological department of The American Museum of Natural History, the Museum of the University of California and its great teaching department—represent periods and places of residence by a great teacher.

In Washington, after the Civil War, the Smithsonian Institution became host for the nation's anthropological activities. From the start, the complementary activities (the care and increase of the national collections and field researches) were carried on by reënforcing bureaus—the United States National Museum and the Bureau of American Ethnology. The names of Otis T. Mason, William H. Holmes, and Hrdlička are intimately associated with the increase of the national collections in ethnology, archeology, and physical anthropology and with the inauguration of programs of systematic researches. The Technological studies of Mason on human inventions and by Holmes on primitive art profoundly affected the exhibits. Mason is credited by Ewers with having discovered and first

[1] Putnam's boys comprise a roster of the founders of anthropology: Boas, Wissler, Dixon, M. R. Harrington, A. C. Parker, Holmes, Hrdlička, Dorsey, and Swanton (Wissler, 1942, p. 199; Boas, 1915, pp. 330–332).

applied to ethnographic exhibits the culture-area concept, an idea that is generally attributed to Clark Wissler (Ewers, 1959, p. 524).

But J. W. Powell (1834–1902), a geologist who was the most successful politician in science of his day, performed the great service of organizing the anthropological work of the government by founding in 1879 the Bureau of American Ethnology and providing auspices for the first research program that was not overshadowed by the need for increasing and curating a collection. With rare insight Powell selected and recruited an unusually gifted group of men who came from other disciplines. His philosophic views, which leaned heavily on the evolutionary theory of L. H. Morgan, were impressed on his colleagues in the Bureau and reached a much wider group of scientists whose research was given a definite direction by their being employed to do specific tasks and whose writings Powell printed in the *Annual Reports* and *Bulletins* of the Bureau, which are the foundation of any library on the anthropology of the New World (Boas, 1915, p. 330; Darrah, 1951).

Putnam, Powell, and Brinton have been called the "Big Three" of anthropology during the museum period 1860–1900 (Wissler, 1942, p. 199). Daniel G. Brinton (1837–1899) was a Philadelphia physician and a pioneer physical anthropologist, linguist, and ethnologist of sufficient attainment to be included with the other two in the American Philosophical Society. Brinton was a great meeting-goer who reveled in academic debate, which made him much feared by readers of papers, for he had a keen, critical mind. He was continually discovering problems for others to work on. We may presume that the main center of anthropological research in Philadelphia today, the University Museum, founded in the year of his death and which has his library, grew logically out of his visions.

We have a special obligation to George G. Heye (1874–1957), collector par excellence, whose particular monument is the Museum of the American Indian in New York. It has the best catalogued and the richest collection of American ethnology in existence, particularly for eastern United States. When the renaissance of interest comes and students want to work on problems for which collections afford the basic information, his institution, under new leadership, promises to be once more an important research center (Mason, 1958). New York City, in fact, with its rich resources of libraries, manuscripts, and collections in supporting institutions, appears to be the center of gravity for Indian studies of the future. A radius of two hundred and twenty-five miles encompasses the principal museums and libraries that are repositories of American Indian collections, books, and manuscripts in the country.

Collections do indeed give a certain stability to centers of anthropological research. A number of institutions formerly sponsored important research programs in archeology and ethnology which were organized,

conducted, and carried through to publication by scientists who attained eminence in the process; but the programs have been terminated, and the institutions no longer support anthropological research or they have merged with other institutions. In this class I would put the archeological programs of the Carnegie Institution of Washington and the Laboratory of Anthropology at Santa Fe. The former has been absorbed in the Harvard complex of museums, and the latter is linked to the New Mexico State Museum.

The Southwest is still a stamping ground for anthropological field workers. There are important university teaching departments at Albuquerque and Tucson with nearby state museums. For a while the glamor of anthropological research passed to Latin America, and of later years to Africa, India, and Southeast Asia.

In fairness, I should mention two other centers of anthropological research and dwell on one. Ann Arbor is famous for specialties in ceramics and ethnobotany that are both supported by and dependent on reference collections. The nearby Cranbrook Institute of Science has a fine Upper Lakes ethnological collection and superb exhibits. In Chicago, the Natural History Museum has brilliant exhibits and rich collections, there is the Oriental Institute, and two universities each have vigorous teaching departments that can utilize the Ayer Collection of the Newberry Library. One senses that here, too, interest has shifted to the universities and they are looking out to the whole world as their field. On the West Coast a healthy revival of the anthropological museum and its vigor in research and teaching were climaxed by the dedication recently of the Robert H. Lowie Museum of Anthropology at the University of California.

COMMUNITIES OF SCHOLARS

Will Cuppy (1931, p. 22) once quipped: "Anthropologists are people who are in museums. They lead sheltered lives."

The beginnings of anthropology in museums of natural history greatly affected its concepts, its methods, and the training of its personnel and their outlook. Anthropologists were, in fact, largely recruited from natural history disciplines. Until after 1900, when universities began to offer programs leading to the doctorate in anthropology, many museum anthropologists had their training on the job in a museum and on museum field parties. Some of our most distinguished practitioners have had no university degrees.

A somewhat similar situation prevailed until 1930, when university department heads in anthropology had first worked in the great natural history museums. Among students, museum jobs in which one could work with collections, do field work, and publish were formerly preferred to teaching posts, and the Bureau of American Ethnology, which required

neither curating nor teaching but offered a continuous fellowship of scholars engaged in field work and publishing, afforded the most sought-after careers. That it is no longer true may be attributed to the tremendous growth of anthropology: most jobs are now in universities, in service and research agencies of state and federal government, and in industry. The number of anthropologists "who *are in museums*" is a small per cent of the total.

What then are the peculiar skills and abilities that qualify anthropologists for membership in communities of scholars called museums? Most large museums and some smaller ones have anthropological collections and recruit trained anthropologists as curators. The first requisite, then, is a demonstrated interest in the study of man and his works. The entering qualification to most museum positions today is a general education with a concentration and a graduate degree in one of the branches of the subject. Anthropology departments in research museums combine three branches of the study of man having ". . . separate but related objectives. *Physical anthropology* concerns itself with the evolution, anatomy, and functioning of man as a biological organism. *Ethnology* deals with the material cultures of the living peoples of the world, their ways of life, their inventions and utensils, the organization of their societies, and so on. *Archaeology* devotes itself to the discovery and interpretation of the buried evidence of past civilizations." (Parr, 1952, p. 11.)

Increasingly the great anthropological collections of the country are in public hands—in national, state, or municipal museums. These institutions adhere to civil service systems for recruiting personnel, and for advancing the scientist through the grades of a career, in an orderly progression to retirement. Admission is by competitive examination, which is based on education and experience, and promotion may be similarly regulated. The great private collections are in university museums or in museums having their charters from legislative or university bodies. In universities the dominant system for classifying personnel is by professorial rank; it is presumed that all professional people have the equivalent of a doctorate; museum curators may be part-time officers of instruction in the university; but regardless of whether they curate collections, research collections, or do field work, their *kudos* lies in research and teaching, and these determine their salary. In a government set-up, in which personnel practices are more rigorous, an order of professional rank obtains, and a job is classified by how the incumbent spends most of his time; fractionated jobs are less common than in universities. The job title is "professor," "curator," "scientist," but not all three at once.

Because of the nature of collections, most museum posts are for archeologists or ethnologists; fewer posts are for physical anthropologists. A few such posts are in art museums having collections of primitive art. In

recent years there has been a shortage of ethnologists with museum training and experience to fill curatorial positions in ethnology (Sturtevant, 1958, p. 12). There are two reasons for this: interest in studies of material culture declined when the locus of the science shifted to the universities, but primarily whole aspects of human culture are unrepresented by objects in the museum. As anthropology broadened its range of interests, problems have as a rule exceeded museum collections. There are now more anthropologists who have been turned away from collections to ideas and peoples. So the museum anthropologist should, first, have an interest in collections and their care and preservation; second, he should be curious about their origin and use in the culture; third, he should be motivated to go to the field and find out more about the objects in question and to see comparable materials in other collections; and he should want to communicate his findings by publication or interpret them through exhibits.

Despite the strong pull to teaching and to field work, the holding power of museums on anthropological personnel is remarkable. Some of its most distinguished practitioners, the most famous anthropologists in the public eye, stick with museum posts as their first love and wander in and out of teaching and public service. It is not just history that holds them in museums, but the dependence on collections is both direct and indirect. Physical anthropologists and archeologists are quite dependent on large series of research materials which are comprised of their own field collections and comparative materials made by others. Museum ranges and laboratories are as necessary as the literature. But even the ethnographer is a kind of ecologist and feels at home with collections, even if his studies are largely field and library oriented and psychological in nature. He is a naturalist first, a humanist second, and a social scientist third.

In contrast with the holding power of museums is the trend beginning in 1900 that was characterized by a shift to universities, which commenced the "academic period" in the history of anthropology (Wissler, 1942, p. 190). Because anthropology is field oriented and deals with the total activities of societies of human beings at a given point of time and throughout history, anthropologists are always involved with other human beings who stand between them and their data. This very preoccupation with culture and with individuals in societies contrasts with the objectivity of the systematic branches of natural science that are most at home in museums. Unless he teaches in a neighboring university, the anthropologist misses the human contact with his field sources which is never quite made up by collections. Museum staffs that do not teach get terribly ingrown and specialized, unless as teachers they are constantly refreshed by contact with graduate fellows.

Too few museums have met this problem. The New York State Museum

grants graduate student honoraria which afford field and laboratory opportunities for young scientists in the best kind of teaching relationship —that of master and apprentice. Each recipient has a university faculty sponsor and reports to one of the State Scientists. The program has resulted in considerable scientific work of an order meriting publication, and the some 100 recipients of these honoraria have gone on to university teaching and research positions. In this regard university museums are best off, and public museums are farthest from the stream of learning.

But such need not always be the case. As the universities go on exceeding their capacity to take more students, two things are happening. They will go on raiding the museums for teachers, and the faculties overburdened with teaching commitments have less time for research. As the universities perform less of the nation's research, some of the slack will be taken up by museums. Then museums will again become refuges for the tired teaching faculties on leave. To the extent that the research museum can afford facilities of its collections, desk and laboratory space for visiting scholars, and perhaps add to these a stipend, it will attract scholars to do research rather than go off to teach in a second university.

The reasonableness of summoning a scholar to direct a research museum seems obvious, but it must be stated, lest the organization and management of our cultural institutions fall to the public administrators who are all too willing, capable, and eager to extend their craft to new enterprises. This is particularly important when public support is involved, because the talents of the scientist-scholar and the administrator are both essential, and they seldom repose in one individual. From what I have been able to learn by participation, visitation, and a reading of patterns of British and American research organization, scientists communicate most readily with administrators who have themselves been researchers, and public administrators know best the ordering and function of budget, personnel, and space, communicating easily with their counterparts in other agencies closer to the loci of power, so that a workable arrangement is to have the latter in staff relationship to the former. Someone has to keep the scientist-administrator out of jail! The administrator's specific scientific discipline is not so important as that he have one, and administrative ability is widely distributed among men of different scientific backgrounds.

A more serious organizational problem in museums is the question of classification of professional positions having multiple duties. Natural history museums are traditionally organized into scientific departments or surveys comprised of anthropology, biology, and geology, with specific breakdowns of these larger groupings depending on the size of collections, program, and staff. It is customary to call the top scientists curators and to rank them according to responsibility. Thus, an organization by disci-

pline or field may not take into account a triangle of interests imposed by the curator participating in several roles: as curator of a collection, as a research scientist in his own right, and as an interpreter (exhibits and/or teaching). In a university the teaching function is paramount, research comes next, then come the collections, and last the exhibits. Of university museums, in which the curators of anthropological collections are also distinguished professors, one may ask, who keeps store? In a particular case one searches through a long roster of honorary and paid curators in vain to find anyone who spends fifty-one per cent of his time on the collections. Some part-time graduate students may function as curatorial aids, but the last survivor of the old curatorial staff who was not a professor has not been replaced. Such men had risen from preparators to curators without becoming officers of instruction, but they were scholars of the collections and they published. The present staff are teachers and research men who divide their time equally, and others are full-time in research (not counting a paper staff of researchers *in absentia* or of fellows and associates). Teachers and research men, given additional funds, will spend them on research. For their current operation the need is for field funds, assistants, laboratory space, library, and classrooms. Lacking these facilities, the work is going on, "in the huddle of collections," to use one professor's phrase. "It will take radical thinking and planning and ruthless execution. The museum needs a whole new staff of curators who would act with collections as librarians perform in relation to books. To do this would mean putting on a crew of professionals with aids to go through the collections and cull out what should be discarded. Then, the whole 'shebang' should be moved to a separate building designed and constructed as a modern museum to be devoted to storage of research collections and exhibits . . . We think about this. We talk about it. Then we go back to our research."

What I have cited is perhaps the most eloquent argument for separation of curatorial functions from teaching and research in a university museum. But even in the public museum, in which teaching is not a first responsibility of scientists, there is a conflict of interest between duties towards the collections and personal research, to say nothing of exhibits and meeting the visiting public. I shall not belabor the point because the curator's dilemma was treated earlier by another member of this symposium (Colbert, 1958). More recently, A. E. Parr, in summing up his thoughts on museums, contributes an argument anent the museum and its scientists for separate research and curatorial staffs. I expect that he would deny such an implication, but it is the logical interpretation of his remarks. He tells us:

> With collections, exhibitions, buildings, annual attendance, and total number of employees more than doubled, the actual number of paid staff positions in scientific departments . . . is exactly the same as it was

> forty years ago . . . Guided by purely pragmatic considerations of the amount of scientific talent needed for other purposes, a much younger and much smaller museum developed a research organization fully as large as it is today. Inspired by a lofty philosophy of research as a separate institutional obligation we have permitted the situation to deteriorate to a point that a harshly practical approach could never have allowed us to reach, and where we now find ourselves with a scientific organization seriously inadequate to take care of our indisputable obligations to the public in other fields than research (Parr, 1959, p. 60).

Parr goes on to discuss reasons for research and the right to do it. It boils down to this: in return for the scientist's judgment and knowledge for the essential performance of other museum functions, he is allowed half time for research of his own choice (*op. cit.*, pp. 61–65).

As I see it, this situation admits of two solutions. First, reduce the number of programs to those of unique competence and give the top scientists, who are curators, salary and professional and technical assistance adequate to their tasks. At that, administrative and public demands will sap more than half of the time of top people. The assistant and associate curators are in greatest need of freedom to do research, and they carry the burden of collections and participate in exhibits. The second solution is more radical. It admits that the maintenance of research is a definite purpose of the establishment and frees its scientists from museum duties to spend more than half of their time on research programs. Here the primary justification is public service. The museum functions (the increase and care of the collections, and servicing collections for research, exhibit, and educational purposes) are carried on by a separate staff who devote the major portion of their time to these duties and have less time for personal research. Their relationship to the scientists in the same discipline is advisory and coordinate, and they report to an executive officer who presides over all museum functions. Both he and the top scientists in each field report to the director. Such a solution was created by my predecessor, Dr. Carl E. Guthe, for the New York State Museum and Science Service. It has its virtues and it has its faults. I have devoted six years to making these complementary moieties work together. Policy questions arise within disciplines, and the curator is still a fragmented person, but there is no question as to who is responsible for the collections and who has research as his first duty. May I conclude with one comment? Without claiming superiority for the type of bilateral organization that I have just sketched, I believe it to be a workable type of paper organization for a cultural institution and research program at the state level where a civil service system of classification of positions and allocation of titles prevails. My comment is this: given superior people and a willingness to work together for the common good, any organization can be made to work.

What is the relationship of anthropology to history in the organization of museums and research programs? Anthropology often characterizes itself as a historical science, and there are many evidences of such cross ties in the literature of both fields, yet the profession of historian is much the senior and manifests no intention of relinquishing its long-preempted position as queen of the humanities and social sciences to an upstart study of man. History has its own teaching departments, its own museums, and its societies of state and local history. In a few states, as in Pennsylvania, archeology as prehistory is subsumed under a State Historical and Museum Commission, with separate series of museum and research titles. Other states and the national government have separate historical and natural history museums, with anthropology (usually archeology) in either, and occasionally predominating as in New Mexico and Arizona. Ethnological collections and study programs have the closest affinities with history, as both are concerned with the course of civilizations and the contracts between cultures. The recent offspring of history and ethnology, ethnohistory, is rapidly developing and is already influencing the thinking of museum personnel; its effects may be seen in the newer museum exhibits of what happens when peoples meet. The old culture-area exhibits based on the analogy of the habitat group are giving way to exhibits of acculturation and cultural conservatism. American Indian collections, for the most part, reflect these processes.

The trouble with museums that have programs of anthropological research is not how they are structured, but, more serious, the lack of provision in the budget for hiring technical assistance and sub-professional help to take care of collections and thus free the scientists who may be curators to do the work for which they are qualified. In university museums students are employed for these purposes, but often without adequate supervision by a curator or preparator on the permanent staff. Graduate assistants can be trained to sort, catalogue, and seriate pottery, but they cannot be depended on to maintain the collections vermin free. The result is that collections are not used, so that they are forgotten, and they deteriorate. Only field collections of the moment receive attention. Services are budgeted to individual research projects and are chargeable to specific grants, and such illustration and photography as may be necessary in the preparation of a report for publication are brought in for the occasion from outside or are requisitioned from central services in the university. A public museum is more apt to have a staff illustrator and photographer, and their services for ongoing research are an irreducible minimum that must not be alienated to other purposes. It is far simpler to lend a photographer to a harassed public relations officer than to try to requisition one and convert him suddenly to the technical requirements of making photographs of objects acceptable for half-tone plates. The same

line of reasoning applies to pool stenographers, who are unused to scientific jargon, and to clerks, designers, and carpenters. The important thing is that there be a scientist-curator to give directions, and that he have a full-time subordinate who may be a technician to carry them out or to supervise the work of other sub-professional help, whether graduate students, temporary employees, or volunteers. The graduate anthropologist will often serve his museum apprenticeship working on collections under a preparator who has no degree and gives no course for credit. The anthropologist may afterward learn research techniques by processing materials under the eye of a scientist and even participate in writing them up for publication, but for general anthropological education the experience of working on collections under an old-time museum preparator has no equal.

IMPORTANCE OF COLLECTIONS

Any discussion of the importance of anthropological collections to the research effort of the nation, for the training of young scientists, as resource materials for the study of the cultural heritage in arts and industries, and their present state of preservation for these and other purposes runs immediately into the question of the nature of anthropological collections, the kinds of things that are preserved in museums, and how these things are distinct and different from systematic collections in biology, and raises the specter of how anthropological collections got into natural history museums in the first place and whether they properly belong there.

In a famous reply to George A. Dorsey's stricture in *Science* on "The Anthropological Exhibits of The American Museum of Natural History," which was occasioned over a radical change in policy that sacrificed system and completeness for the significant activity in the culture, Franz Boas outlined "Some Principles of Museum Administration," pointing up the difference between anthropological collections and natural history collections (Dorsey, 1907; Boas, 1907, p. 928). "An assemblage of material such as is found in anthropological collections consists entirely of things made by the various peoples of the world—their tools, household utensils, their ceremonial objects, etc. All of these are used in the daily life of the people, and almost all of them receive their significance only through the thoughts that cluster around them." Thoreau's homily on the arrowhead found near Walden Pond expresses this relationship nicely: "Time will soon destroy the works of famous painters and sculptors, but the Indian arrowhead will balk his efforts and Eternity will have to come to his aid. They are not fossil bones, but, as it were, fossil thoughts, forever reminding me of the mind that shaped them . . ." (Shepard, 1927, p. 318). Boas confirms this by saying, ". . . frequently in anthropological collections . . . a vast field of thought may be expressed by a single object or by no

object whatever, because that particular aspect of life may consist of ideas only . . ." (Boas, 1907, p. 928).

Owing to natural destruction archeological collections comprise only a part of the objects that originally made up the inventory of a culture. Not only do cultures differ in content, but no outline of cultural materials has ever been devised that is satisfactory for all cultures. It is the essential psychological and historical relations among cultural phenomena that are the real quarry of the anthropological hunt. Because Boas grasped this essential truth he rejected Dorsey's defense of the exhibit that would cast all cultures in a single mold.

Collections in physical anthropology are the precise analogues of natural history collections. "For cultural objects the difference consists in the trifling importance of the specimens as compared with their functional importance in anthropology, and to the fact that all of the specimens are primarily incidental expressions of complex mental processes that are themselves the subject of anthropological inquiry" (Boas, 1907, p. 928). For this reason Boas would treat anthropological collections like collections of art and of artistic industry rather than like natural history collections (Boas, 1907, p. 929).

In relation to research, the size of a museum is a function of its history and the support available for accessions, but, more important, policy on accessions determines in what areas it will collect and what specialties it will cultivate. Few museums at the national level can any longer be all things to all people. The British Museum attempts to preserve for future generations the treasures of the Empire and its dominions. The United States National Museum has a similar responsibility for the New World and is the repository for exploring expeditions and surveys which receive official support. Consequently, its collections of American Indian ethnology, the long series of skeletal remains of American Indian populations, and the constantly growing collections in New World prehistory enhance its position as a national resource for research. The provincial or state museum has a comparable responsibility in smaller compass. Because of an early start towards the Indian collection, the New York State Museum is a center for Iroquois studies (New York State, 1953, Education Law, Section 234). "The essential justification for the maintenance of large museums," to use Boas' words, "lies wholly in their [being] . . . the only means of bringing together and of preserving intact large series of materials which for all time to come must form the basis of scientific inductions" (Boas, 1907, p. 929). One might bewail the loss of old collections, which deteriorated awaiting the establishment of large museums for their preservation a century ago, for now there is no way to check the deductions of earlier observers on tribes that have now vanished. One may rejoice at the enormous progress that has been made

in anthropological research since large museums were established. A corollary of this argument is that large series must be kept intact and should not be distributed nor be allowed to deteriorate. I can assure you that, in chasing Iroquois masks through a dozen museums in 1940, I was delighted to find a series of a hundred individuals of the same period in the New York State Museum, and a comparable series from another quarter and time at the Museum of the American Indian (Heye Foundation). Thus one learns what is characteristic.

In relation to research, Parr has deplored the competitive spirit of the collector which has too long been allowed to prevail over the cooperative needs of disinterested science (Parr, 1959, p. 49). Collections are badly distributed and fragmented, from the viewpoint of the specialist, who could work more efficiently with them at hand. But as we are now constituted, it is difficult for one museum to relinquish its holdings to another that has the specialist. In anthropology we do not know for certain where the collections are, who has them, and how they are distributed. As we shall see in a moment, anthropology lacks indexes to ethnographic collections by areas, a situation not in the least resembling botany, which has its "Index Herbariorum."

Research collections in anthropology vary enormously in quality, depending upon how they are documented. If ethnography, archeology, and physical anthropology be treated separately, four kinds can be distinguished[2]:

1. Field collected: consisting of objects and documentation in the form of data gathered by ethnographers.
2. Resident collected: by long-time resident collector who is knowledgeable; he is a native, trader, missionary, administrator.
3. Gentleman's collection: fine pieces from an area.
4. As *objets d'art:* (This category I have termed "Ethnological Chippendale." It is what somebody thinks it is.)

Coverage by the first criterion is estimated in the following order of rank at The American Museum of Natural History:

1. North America
   South America: the Amazon and Chaco
2. Melanesia: New Guinea
3. Northeast Siberia: Yakut and Koryak
4. Polynesia: incomplete
5. Africa: rising

A professional name and career can be attached to each area: Wissler, Tschopik, Métraux; Mead; Bogoras and Jochelson; Shapiro; Bascom.

A second set of distinctions is possible within the first criterion.

[2] The criteria were suggested by Miss Bella Weitzner of The American Museum of Natural History.

Primary collecting—by a staff ethnologist who does field work on behalf of the museum and includes collecting in his field design (Spier on the Havasupai; Mead on Bali)—differs from *secondary collecting*—a by-product of research by an anthropologist on another problem. When a scientist is going to an area he may be asked to collect for and on behalf of the museum, for which he receives an advance towards the expense of the expedition and of which he returns an accounting with the documented collection. In this case collecting is optional; it is required of the permanent staff. Either relationship to the museum may result in first-class material, well catalogued, for the assumption is that the collector will himself use the material as data towards an ethnography. Other scientists (botanists, ornithologists, mammalogists) have frequently proved to be good collectors; their documentation may be fair, but it is slanted. The same result happens when the archeologist does ethnological collecting.

Native-collected material may rank with specimens field-collected by an ethnographer, and may even be better documented by having the added advantage of being selected by members of the society who are carriers of the culture. In the past a number of such collections were made by natives employed on museum staffs on the Northwest Coast and on the Plains in the heyday of collecting; they never were written up and they offer today, where preserved, opportunities for the museum ethnologist beyond the poverty of material culture extant in the North American field. Thus the Shotridge Collection at the University Museum of the University of Pennsylvania in Philadelphia, George Hunt's Kwakiutl materials in several museums, and the LaFlesche Osage collections at the United States National Museum and at Harvard University deserve mention. The writing up of an ethnography of a place from the specimens in the museum collections is a task that can probably be done best by a resident staff member or by an area specialist.

Every ethnographic collection contains period pieces that as *objets d'art* have made the museum famous and would be much sought after today, should they go on the block, as collector's items; these I call "Ethnological Chippendale." They lack documentation and may be ascribed by experts to a period and place. They may once have formed parts of gentlemen's collections, or they may have for a time reposed in earlier museums and historical collections with family and state papers. To this latter genre belong fine specimens from the old Algonquian tribes of New England and from the Iroquois of New York that today may be seen in the Peabody Museum at Harvard, having been deposited there by the Massachusetts Historical Society, the Boston Museum of Fine Arts, and the American Antiquarian Society. The scholar's task now is to ascertain which, if any, of these relate to historic events as, for example, to Timothy Pickering's treaty negotiations with the Six Nations (1791–1794). This

is a kind of antiquarian detective work that offers some excitement and no little satisfaction. Anyone who has struggled with the problem of matching specimens with references to them in the historical literature for eastern North America has my sympathy. Some surprises occur. Imagine the embarrassment of the New York State Museum when X-ray revealed that the Hiawatha wampum belt has one lead-glass bead and cannot, therefore, date from the pre-Columbian founding of the Iroquois Confederacy (Fenton, 1960a)!

At the turn of the century, a number of American painters, in the Catlin tradition, collected ethnographic specimens of unusual merit to adorn their studies and to serve as props in paintings of the Old West. John Mix Stanley, Gary Melchiors, DeCost Smith, Frederick Remington, Stevens of Philadelphia are names that will suggest others. They are the forerunners of the current fashion of collecting primitive art. Most of the artists mentioned went into the field, but they also patronized dealers. Their collections contain sensational bits that Ewers and others, knowing the area, its materials, and periods, have been able to exploit. Happily these collections are in museums.

The most serious threat to the ethnographical museum today is the collector of primitive art. His position in relation to ethnography is not unlike that of the arrowhead collector at the turn of the century who was succeeded by the amateur archeologist, or the collector of wooden Indians, for whom pride of possession conferred some status. Some persons are known to buy anything from dealers, and four or five such men are bidding the museums out of the market. Dealers finance collectors, keep the best pieces to sell to wealthy patrons, turn over the balance for sale in museum shops, and the remainder may be offered to the museum. Prime ethnographic areas in Africa and Melanesia were denuded by dealers' pickers in recent years. Another pattern is for a gallery to buy the ethnographical collection of a museum that has found it too difficult to exhibit and too expensive to curate and that needs ready cash, and the gallery then proceeds to offer the best pieces to a sophisticated public. No museum can possibly compete with the prices asked. But the gallery may donate the articles of everyday use that do not sell (adzes, bone-fleshing tools, fishhooks, and the humbler baskets) to a college museum.

In a way the ethnologist complains of his own success. His publications on katchinas, false-faces, and the art of the Northwest Coast, aboriginal art of Australia and New Guinea, and African sculpture have inspired a variety of hobbyists. But the tragedy of creaming the ethnographic market and exhibiting primitive art by itself, from a scientific viewpoint, is that the material is lifted out of cultural context, and its relationship to the humbler aspects of the lives of the folk is distorted. (See also Shapiro, 1958.) It destroys the whole that the anthropologist has striven for fifty

years to see and delineate. Students in the next generation are going to have to travel to two different kinds of museums to see and comprehend a material culture.

A defense reaction has already manifested itself. Museums, having abandoned habitat and culture area exhibits, are themselves searching storage collections for examples of primitive art and lighting the objects to the best advantage. Rainey even questions whether museums belong in the structure of education but ascribes them to the world of intellectual entertainment (Rainey, 1955, p. 44). (A comment for later discussion would be that if museums expect state aid they had best advance their claim as educational establishments.)

From the beginning, the planning and preparation of exhibits have exerted a continuous feed-back effect upon collections and upon research. The effort to enlighten the public in terms of the theory of the day has stimulated collecting; the need to interpret objects has sparked original investigations into other areas of culture besides technology (social organization, religion, ecology, and esthetics); and the execution of exhibit plans demands decisions that will stand up under constant scrutiny but that can remain ambivalent in research reports. This process is clearly seen in Ewers' discussion of American Indian exhibits in the Smithsonian Institution (Ewers, 1959). From DuSimitière's first showing, as curiosities, of two masks brought back to Philadelphia by Sullivan's 1779 expedition to the Iroquois towns (DuSimitière, MS), through Secretary Henry's attempt to make the national Indian collection representative of the whole country, to the efforts of Mason in this country and Pitt-Rivers in England to apply taxonomic principles of the biological sciences to the classification of artifacts and to extend the principle of evolution to the development of inventions, and the final abandonment of taxonomy for an ecological principle in the culture area exhibit, may be seen a constant interplay of concept and graphic presentation. The activity that epitomizes a culture, such as Holmes's famous Polar Eskimo group in the United States National Museum or Dorsey's Pawnee sacrifice to the morning star at Chicago (Linton, 1923) summarizes a whole area of research. Spoehr and Quimby's cartoons of Indian kinship systems at Chicago seek to extend the museum exhibit to include areas of culture not represented by objects, and present plans to illustrate the acculturation process with changing Indian material culture will send ethnologists back to the field to fill the gaps in previous information. Undoubtedly the rage of primitive art is provoking and supporting new field studies of esthetics and design.

The two branches of anthropology that are most dependent on museum facilities are archeology and physical anthropology. Archeology deals primarily with that portion of human artifacts that survive the ravages of time. Archeology is museum bound, but the archeologist cannot depend

on collections solely for research. He must go to the field, and he no longer goes primarily to collect. To be certain, it has always been easiest to persuade trustees to put up money for an archeological expedition that promises spectacular loot. But as the museums fill up and storage becomes the number-one problem, expeditions go out but bring back less than formerly, working up as much as possible in the field. In the future they may not bring back collections at all, as most countries now have rigid antiquities laws restricting the export of collections. As the potsherds are typed, counted, and dumped back in the fill of the excavation, and only the "fictional types" are saved, space for the storage of collections becomes less necessary and laboratory facilities become more important in the museum of tomorrow.

How vital are the collections, then, to research today? It is an illusion of some administrators that we can dispense with collections, even though they are liabilities draining budgets for their care and preservation or are quietly deteriorating in storage rooms. New World archeologists agree that the older collections must be preserved and are essential for research purposes. Good comparative collections are necessary for making routine identifications, when it is simpler to place an object in a series than to guess or remember what may be in another collection (especially true in ethnobotany, a systematic science, but less true in ethnology where specimens are unique). Much of the material that is already in the older collections cannot be reproduced by further collecting or excavation and must be worked over for reinterpretations of older data and for a reëvaluation of old problems with new approaches in the light of contemporary problems.

In the words of one prehistorian, "The essential weakness of the collections in anthropology is the field investigator's screen of theory at the moment. Material is always selected and collected by such guide lines. The older workers kept only whole specimens. Today we drag in tons of potsherds. Fictional types are saved (those that conform to statistical abstractions); we throw out the rest. Charcoal was formerly discarded as valueless; but it is now sought and saved for C–14 analysis and dating" (James A. Ford, personal communication). There are in museums today vast archeological collections that were gathered on salvage operations which have not yet been studied. They present an opportunity for students to work over large series that were field-collected by men yet living who wrote the documentation. Such materials are researchable and superior to the older collections which demand sophistication and yield uncertain results.

How vital are collections to future research? The rapid disappearance of native societies, cultures, and languages is a matter of international concern (Heine-Geldern, 1958), and it is a foregone conclusion that the

native arts and crafts will vanish first, because material culture is most amenable to change. We know from the history of such events in North America that the process is irreversible and inevitable for the rest of the world. Likewise, the expansion of cities and the construction of superhighways in America threaten to cover in concrete the prehistoric settlements of the native inhabitants. The resources for future research in archeology will depend on field collections that are carefully made, adequately documented, and preserved in museums. What I as an administrator sometimes regard as spurious accuracy and question as exaggerated record keeping is, I am assured, vital to future mathematical analysis and will enable a second scientist to confirm or deny contemporary results. Collections that were once carefully documented even though published are still being studied.

Despite the opportunities for research in museums, studies of material culture do not occupy a high place in current anthropological priorities. Technology has lost students to social anthropology, reflecting a shift in theoretical interest from museum studies to field work, a trend that commenced fifty years ago, when the larger museums became space conscious, and ethnologists became preoccupied with studies of ceremonialism and social institutions. This trend partly reflected the disappearance of native crafts and native sources on the old arts in North America. Elsewhere the picking has been better. My own inquiries among museum and university personnel afford small encouragement over the findings of a Conference on Museums and Anthropology, held at the University Museum in 1954. Then Donald Collier and the late Harry Tschopik assessed the role of the museum in research, teaching, and theory and asked the telling question, "Is material culture, as a proper subject for anthropological investigation, a dead duck?" (Collier and Tschopik, p. 776). Because few people use the collections in storage now, the Conference noted the opportunity for advancing acculturation studies by using museum materials in cooperation with archeologists; it urged missionizing university departments to use the collections as teaching aids and encouraging graduate students to select material culture studies for thesis projects. The earmarking of fellowships for this purpose would get it started.

Two other points reënforce the nature of the cultural lag that reposes in museum anthropology. Museum anthropologists are the custodians of the historical approach in contrast with the functional approach of most social anthropologists. And the gap between museum research and exhibits is widened by the lag between the former and research in the universities. Until some closer rapport is established between university museums and university departments of anthropology in finding problems of mutual interest that advance the science, the professors will consider the curators old-fashioned, and the students soon catch on. Mutual educa-

tion and a change of museum policy are indicated.

That material culture studies do not enjoy a higher place in Britain is small comfort. Hutton's plea to the Royal Anthropological Institute went unheeded in English universities which are the seats of social anthropology (Hutton, 1944). The only people I met in 1952 who were studying collections in the British Museum were Americans and Germans, but the collections are in excellent condition. Some hope is manifest in the museums movement to get other museums to preserve their ethnographical collections (Digby *in* Cranstone, 1958). Meanwhile some first-rate monographs on technology and primitive art based on old collections from North American and Africa have appeared from Oxford, Berlin, and Leiden (Turner, 1955; Krickeberg, 1954; Gerbrands, 1957).

The resources in the nation for the study of the arts and industries of rapidly disappearing native peoples of the world are in no way correlated with their use. In the words of one museum director situated but a block from a teaching department, "There is little clamor from university students to utilize the ethnographic collections." The same is true when students take their classes in the museum. Material culture is not being stressed in teaching departments, if taught at all, and only here and there is there genuine enthusiasm. There is no doubt but what material culture studies need proselytizing in anthropology departments. A word dropped in class is not sufficient; the museums will have to put money on the line. This past year, the New York State Museum awarded two honoraria to Columbia graduate students to work on Iroquois collections in the New York area. But this small gesture bears no relationship to the need which cannot be measured without valid statistics on the use by research scholars of study collections for one or more weeks per year. In general, such use seems to be declining.

Hope lies in three directions. The exhibits in large city museums get some use in the teaching of anthropology in neighboring colleges, but the most constant use is in teaching social studies at the elementary and secondary levels. Any interest in technology developed from scouting becomes age-graded and does not carry over to college. Undergraduates, in my experience, are loath to admit to such interest. But primitive art is now fashionable, and its devotees do come to the museums and seek out the study collections. But as, in the main, they are not trained in world or regional ethnography, they are apt to pick atypical pieces to represent a culture. When professional art historians are employed on research staffs of new museums to build up photographic registers of art specimens in other museums, the study of material culture acquires active scholars.

A third source of hope is manifest in the popularity in this country, Canada, and Britain of television programs, "in which ethnographical specimens share pride of place with the treasures of the archeologist"

(Digby *in* Cranstone, 1958), which send viewers to their attics to seek out treasures and to museums to compare their finds and to stump the experts. How shall we service growing public interest short of training more experts? The motivation to learn has already been supplied.

If, as Cranstone says, "The primary function of an ethnographical collection is to illustrate the range of human adaptation to different environments . . . ," then we are in a poor position to say what resources the nation has for fulfilling this purpose, lacking an inventory of collections. One distinguished professor of anthropology has gone so far as to propose to me on two occasions a moratorium on further field work until the materials, both collections and manuscript, which now repose in the towers and storage rooms of our older museums, comprising the journals and field notes of previous workers and their specimens, are listed and evaluated for research purposes. If we admit that the material culture of the American Indian can only now be studied in such repositories, how do we propose to interest students? How would we support their researches?

An "Index Ethnographicum," comparable to the famous botanical index, could be accomplished on a broad scope for North America by a committee, with a staff of several graduate students. Having identified the problem and roughed out the resources known to its personnel, the committee would send out not a questionnaire but someone to spend a week or more at various museums, eliciting from curators the information that they are too busy to put down on paper. I would anticipate complete cooperation. To entice graduate students to research this area, the committee would have to identify some problems bearing on both anthropology and behavorial science. Otherwise, the field and the collections will fall entirely to historians, untrained writers, and primitive-art enthusiasts. One would scarcely expect the country's leading theoretician in anthropology to have strong museum interests, but he was the one person interviewed, in a round of anthropological museums, who was both interested in doing something in this area and constructive in suggestion: "This is something that has been on our conscience and that we have talked about."

An index to the study collections in anthropology will cost money. How can it be financed? Three approaches require different financing and involve separate levels of responsibility. First, each museum might make an inventory of its own collections and publish a check list. Second, area specialists might do the same sort of thing for the country. Third, a national committee, employing graduate students, might do the whole country. Proper coordination needs a central committee who would identify other area experts in this country and abroad. So much for ethnography.

Archeology and ethnography should be done separately. Each presents

special problems. Physical anthropology is yet a different problem, in some ways simpler because there are fewer, more homogeneous collections. But all three are found in museums and should be represented on a general committee having panels for each. *I recommend the formation of such a committee on anthropological collections.* A committee of seven, meeting twice a year and employing three graduate students, should have a budget of $10,000 for travel and research, and another $10,000 for the preparation and printing of the "Index." Is $20,000 too much for the assessment of the worth of collections, the making of an index, and for recommendations of a policy on their preservation?

With fair certainty I can predict what the survey will find. It is in for some surprises and some shocks. The contrast between exhibit areas and storage areas in most museums convinces me that the whole concept of storage is wrong. We should stop saying "storage" and start talking about "ranges," "laboratories," and "research collections." We have led ourselves into a semantic trap that Dorsey foresaw in 1907 when he protested against the retiring of ethnological specimens from exhibit: "I am convinced that collections, especially those of ethnology which are forced into retirement always suffer. There is not only the inevitable deterioration which always follows when ethnological specimens are packed away . . . , but there is especially that loss of personal interest . . . The argument that such collections are always available for study is on the whole specious . . . These collections are rarely demanded for study" (Dorsey, 1907, p. 585). In other words, out of sight, out of mind!

While I do not for a moment agree with Dorsey that everything should be kept on public view, he has a point. Some of the really priceless collections have deteriorated beyond recovery for research, wiping out the reason for preserving them in the national interest. The collections will take a different position in the affection of scientists and administrators when anthropologists start thinking about them as resources for research.

"The proper care of accumulated material is no less important than beautiful exhibits" (Boas, 1907, p. 930). One way of preserving ethnological collections from fire and insect damage is by building vented masonry rooms fitted with open shelving, to allow ready inspection, and equipped with airtight doors which facilitate fumigation. This method has advantages over using the bottoms of cases in exhibit halls, of which the United States National Museum cases and the modern Lane cases are the heirs. The first method works so long as the rooms are light-proof and remain vermin free, but it fails utterly the minute the housekeeping sags. The use of individual cases has advantages of mobility, localizing areas of damage and infestation, but they have the defect of their own security: the specimens are out of sight and forgotten. The cases themselves are expensive; few museums budget to purchase cases annually.

FACILITIES FOR RESEARCH

Modernization of facilities for research lags behind exhibits in most museums. Space is the foremost problem, a difficulty that started with the design of museum buildings, a generation ago, when architects failed to provide study ranges separate from exhibit areas and from educational activities. Anthropology has accommodated its collections in some museums by preëmpting places not suitable for other purposes, thereby scattering its storage and crowding its holdings into attics, nooks, crannies, basements, and other undesirable space that is poorly lighted, ill-ventilated, or subject to damp. The ingenuity of curators in these circumstances is amazing. Work space in ranges may even be preëmpted to other research unrelated to museum programs.

George Heye was far in advance of his day when he went up to Pelham Bay and erected a storage building on cheaper land, which has long been a joy to scholars traveling by car and transporting photographic equipment. Large series are available on demand. Whether to follow his example or to build a wing for anthropology presents attractive alternatives. Scientists living in the suburbs advance the safety of the collections in wartime and note the advantage to be gained in productivity of uninterrupted research time near home. But an off-campus storage and research center imposes a different staffing pattern, because technicians go with the collections; duplicate catalogues may be necessary, although closed-circuit TV would facilitate communication; and transportation for collections and personnel runs up the operating expense. Annexing a wing of laboratories and ranges is probably more efficient; it keeps staff and collections near at hand and accessible to exhibition and education programs and to the visitor who seeks answers to his questions from the scientist. There seems to be no escape from public service.

A new wing of laboratories has just been added to the New York State Museum for the work of the State Science Service and has been equipped with instruments for the work of our scientists. Therefore I find the argument compelling that, in this day and age, museums should advance their claims for new facilities for specific research programs in terms of broad areas of basic research which will produce the background information on which programs in higher education and economic advances rest. Facilities need not be bought with a pragmatic fallacy. Nineteenth century methods of natural history observation are not adequate in the day of experimental science. The geologist needs more than a hammer and hand lens; microphotography and electrospectroscopy are justified for more accurate identifications. The archeologist teams up with paleontologists in demanding a Cavitron for cleaning specimens and justifies it for the labor it saves. The field ethnologist no longer seeks informants with pencil and notebook but must have the latest magnetic recording devices. Some

archeological centers may go in for carbon-14 analysis and fluorine-dating equipment. Such is the apparatus that Americans have come to expect of scientists. Ours is a pragmatic culture; we like devices, we demand service, and we applaud activity.

Whatever the gadgetry, anthropology continues to be an affair of the mind and will remain centered on the museum and library to the extent that it is dependent on specimens and books. The anthropologist of the future will spend more time in the laboratory than his predecessors, and those centers that afford such facilities will attract and hold scholars. The usefulness of libraries such as that of the Peabody Museum at Harvard, that at the Bureau of American Ethnology, and the Newberry-Ayer Collection will never be supplanted, but they will be greatly enhanced by provision of laboratory space for resident scientists and ranges for the reference collections.

SUPPORT

Present patterns of support are inadequate for maintaining and operating the nation's anthropological collections. Buildings are antiquated and poorly designed, they provide neither adequate ranges for study collections nor laboratory facilities, they are jammed to the eaves with baskets and spears and totem poles from the margins of the world, they are understaffed with curators and technicians, and the collections are consequently in appalling condition for research or exhibit purposes. If we can demonstrate that the collections and the communities of scholars that attend them are assets to the structure of higher education in America, and the public interest is sufficiently aroused, public support will be forthcoming. I suggest that the support will be at three levels: national, state, and local.

Where research is the program and the staff develops a reputation for public service, support is available from public sources. Thanks to the missionary efforts of Dr. Detlev Bronk and the National Academy–National Research Council, the Federal Government through the National Science Foundation is supporting programs of basic research on an individual and institutional basis. In a report of the Foundation, "Basic Research, a National Resource," museums were mentioned among "other institutions," and anthropology is one of the constituent disciplines. Individual anthropologists in museums have received grants in support of projects from the Foundation, and some rather sizable grants have been made to teams at museums, including anthropologists as principal investigators. Most of these have been field projects. It seems utterly logical that facilities grants to museums should fall in the same category as grants to universities for laboratories and instrumentation, and to systematic museums for the purchase of cases, and that similar programs should be developed for anthropological museums. Anthropology has the added

advantage of participating in the social sciences and humanities, for it spans the range of man's activities and interests, with the consequence that those research areas that fall within the purview of the National Institutes of Health find additional support. The policy seems to be to support research in the sciences that bear on mental and public health.

When taken together, the amount of state support for anthropological programs is impressive. From cabinets of antiquities, to state Indian collections, to state museums, to anthropological surveys, to teaching departments in the state universities, there has been an orderly transition and development over the last century. As are the natural history surveys and their offspring, of which anthropology is a sibling, these state-supported establishments are part of the apparatus of public education. They do research, they curate collections, they teach, and they interpret to the general public who support them by taxation. Service and education are the two demands that the public makes for its support. Entertainment is something for private citizens and should not be had for public dollars. This is one of those odd paradoxes in our culture: education is public, but fun and sin are private.

The pattern of municipal support of museums is based on the need to support these institutions as cultural resources and as extensions of the educational system. Private support is sought for culture and for research, and the city pays for services to the schools and maintains the buildings. In some cities it pays the entire cost of the museum program, including research. Both out-migration from cities to suburbia and the influx of culture seekers from the counties have deprived municipalities of tax revenues and increased the demand for services. As with schools and public libraries, the new pattern will be state aid for museums. The museums are making their claim as educational establishments. State-aid formulas will depend on three fundamentals: (1) What is a museum? (2) Legislation defending the term "museum" from encroachment by attractions and the entertainment industry. (3) Some fraction of existing support. State aid will probably not be available to private museums, and it will be so designed as to encourage larger municipal support. Thus it will follow lines of present local assistance programs but will not affect programs in research, except by reducing other expense.

The survival of museums in anthropology will rest on two things: their contributions to research and to education. In surviving they will return to their original purpose, as communities of scholars.

SUMMARY OF FINDS AND RECOMMENDATIONS

Museums will continue to be centers of anthropological inquiry, and they will attract and hold scientists who wish to pursue research on problems for which collections are a focal point of orientation to the field.

But because much of anthropological inquiry lies in problem areas that are not represented by objects in museums, real inducements are necessary to attract graduate students to work on problems of material culture *per se* and to persuade them of the relevance of objects to other areas of human culture. A whole range of linguistic and semantic phenomena are locked up in museum specimens which afford cues to informants. The implications of teaching in the museums should be obvious. But, apart from collections, museums that are able to afford laboratory space to visiting scholars will draw researchers from the universities. The universities may do less of such research in the future and the public museums more, and increased cooperation in various ways between public museums and universities is mandatory for the survival of both. Collections that cannot be replaced are the records of science, and we might even designate the repositories of key collections as "museums of record." As primitive peoples vanish, the collections are all that remain as resources for the study of their arts and industries and to remind us of the displacement of the native peoples of the world. But we do not know where these things are or how they are distributed. The need of an inventory is urgent, and a survey of collections in the national interest may disclose some appalling conditions. Overcrowding, neglect, a shift of interest away from collections, shortage of personnel, and a drying-up of the sources of private support have all been contributing causes. The need of new facilities is great, especially for research, and the collections should be considered in this light. We should cease talking of storage and start talking about collections as resources for research on problems of scientific and cultural importance to the nation. Anthropology has a similar need for laboratories and is shifting towards newer methods of research along with its natural history siblings in the museum. Finally, it is predicted that the support for these advances will come from public sources, because museums have a definite place in the apparatus of continuing education, and the research that is performed in them is a public service and is in the national, state, and local interest. Formulas will be worked out following the existing local patterns of support: the federal government might grant facilities, the states might match these funds and grant local assistance for service rendered beyond city limits, and the cities will have to give the primary support for service to the schools. There will still be room for private gifts which should become more meaningful when not burdened with maintenance and operation. Philanthropy might go for those areas of theoretical research that at first seem remotely related to public service, and create advantages for school children that might appear at first blush to be frills. If these things come about, as I am confident they will, it rests with the museum profession to assist the states in defining what is a museum and writing legislation to protect

the museums that are educational institutions from predatory enterprises.

In the light of these findings, I recommend:

1. The creation and earmarking of fellowships and honoraria for the purpose of attracting graduate students in anthropology to select as dissertation topics problems involving the use of museum collections.

2. The creation of additional positions for curators and scientists in museums.

3. That the National Science Foundation be asked to impanel a Committee on Anthropological Collections as Resources for Research, that this committee be asked to identify new areas for research on which the collections impinge, and especially that they prepare an index to the collections of the nation; that a grant of $10,000 be made for the use of the committee, and $10,000 for the preparation and publication of an Index.

4. That the public museums establish closer ties with the universities and possibly work out exchanges of personnel.

5. That research be recognized as program in museums and that positions and facilities be created for activities primarily of a research nature and at the same time provide other positions for the care of the collections and make them available for research and educational purposes. In some cases, this will mean separate facilities designed and maintained for a particular purpose and supported by the appropriate authority.

6. That the American Association of Museums join the several states in seeking legislation to protect the term "museum" from encroachment.

7. That we advance the museum as an educational establishment and seek state aid for its support.

8. That a program of facilities grants be set up at the National Science Foundation for anthropological research museums.

REFERENCES

Boas, Franz: *Some Principles of Museum Administration.* Science, new ser., vol. 25, pp. 920–933. 1907.

Boas, Franz: *Frederick Ward Putnam.* Science, new ser., vol. 42, pp. 300–332. 1915.

British Museum: *Handbook to the Ethnographical Collections.* London. 1910.

Clarke, John M.: *James Hall of Albany: Geologist and Paleontologist, 1811–1898.* Albany. 1923.

Colbert, E. H.: *On Being a Curator.* CURATOR, [vol. 1], no. 1, 7–12. 1958.

Collier, Donald, and Harry Tschopik, Jr.: *The Role of Museums in American Anthropology.* Amer. Anthrop., vol. 56, pp. 768–779. 1954.

Cranstone, B. A. L.: *Ethnography, Handbook for Museum Curators.* (With a Foreword by Adrian Digby.) London, The Museums Association, pt. C, sect. 4, pp. 1–40. 1958.

Cuppy, Will: *How to Tell Your Friends from the Apes.* New York. 1931.

Darrah, W. C.: *Powell of the Colorado.* Princeton, New Jersey. 1951.

Dorsey, George A.: *The Anthropological Exhibits of The American Museum of Natural History.* Science, new ser., vol. 25, pp. 584–589. 1907.

DuSimitière, Pierre Eugene: *Memoranda, 1774–1783.* (Manuscript notebook in the Manuscripts Division, Library of Congress; courtesy of John C. Ewers.)

Ewers, John C.: *A Century of American Indian Exhibits in the Smithsonian Institution.* Rept. Smithsonian Inst. Washington, 1958, pp. 513–522. 1959.

Fenton, W. N.: *The Hiawatha Wampum Belt of the Iroquois League for Peace: a Symbol for the International Congress of Anthropology.* Selected Papers of the Fifth International Congress of Anthropological and Ethnological Sciences, Philadelphia, September 1–9, 1956 (A. F. C. Wallace, editor), Philadelphia, University of Pennsylvania Press, pp. 3–7. 1960a.

Fenton, W. N.: *Review of "Lewis Henry Morgan: the Indian Journals, 1859–1862."* Edited by Leslie A. White. Science, vol. 131, p. 404. 1960b.

Gerbrands, A. A.: *Art as an Element of Culture, Especially in Negro-Africa.* Mededel. Rijksmus. Volkenk., Leiden, no. 12. 1957.

Heine-Geldern, Robert: *Bulletin of the International Committee on Urgent Anthropological and Ethnological Research.* Vienna, no. 1, pp. 1–47. 1958.

Hutton, J. H.: *The Place of Material Culture in the Study of Anthropology.* Jour. Roy. Anthrop. Inst., vol. 74, pp. 1–6. 1944.

Krickeberg, Walter: *Altere Ethnographica as Nordamerika im Berliner Museum für Völkerkunde.* Baessler-Arch., new ser. 2, vol. 27, pp. 1–280. 1954.

Linton, Ralph: *The Sacrifice to the Morning Star by the Skidi Pawnee.* Dept. Anthrop. Leaflets, Field Mus. Nat. Hist., vol. 6, pp. 1–18. 1923.

Mason, J. Alden: *George G. Heye, 1874–1957.* Leaflet Mus. American Indian–Heye Foundation, no. 6, pp. 1–32. 1958.

New York State: *Education Law 1 to 2100. In* McKinney's Consolidated Laws of New York Annotated, Indian Collection. Brooklyn, book 16, pt. 1, sect. 234, p. 108. 1953.

Morgan, L. H.: *Report to the Regents of the University Upon the Articles Furnished to the Indian Collection.* Third Annual Report of the Regents of the University on the Condition of the State Cabinet of Natural History, and the Historical and Antiquarian Collection, Annexed Thereto. Revised Edition. Albany, pp. 59–95. 1850.

Parr, A. E.: *The Museum Explores the World: Report of the Director.* Eighty-third Ann. Rept. Amer. Mus. Nat. Hist., pp. 9–28. 1952.

Parr, A. E.: *Mostly About Museums.* New York, The American Museum of Natural History. 1959.

Peabody Museum, Harvard University: Eleventh Report of the Peabody Museum of American Archeology and Ethnology, for 1878, pp. 177–179. 1878.

Rainey, F. G.: *The New Museum.* Univ. Mus. Bull., Philadelphia, vol. 19, no. 3, pp. 1–53. 1955.

Sarton, George A.: *A History of Science.* Cambridge, Massachusetts, Harvard University Press, 2 vols. 1959a.

Sarton, George A.: *Forgotten Men of Science.* Saturday Rev. Lit., March 7, 1959. 1959b.

Shapiro, Harry L.: *Primitive Art and Anthropology.* Curator, [vol. 1], no. 1, pp. 46–51. 1958.

Shepard, Odell (ed.): *The Heart of Thoreau's Journals.* Boston, Houghton Mifflin Co. 1927.

Sturtevant, W. C.: *Anthropology as a Career.* Washington, Smithsonian Institution. 1958.

Turner, Geoffrey: *Hair Embroidery in Siberia and North America.* Occas. Papers Technol., Pitt Rivers Mus., Oxford, vol. 7, pp. 1–83, 26 figs., 16 pl., 2 maps. 1955.

Wissler, Clark: *The American Indian and the American Philosophical Society.* Proc. Amer. Phil. Soc., vol. 86, pp. 189–204. 1942.

THE ROLE OF THE RESEARCH MUSEUM IN SCIENCE

The Research Museum of the Physical Sciences

ROBERT P. MULTHAUF, HEAD CURATOR
DEPARTMENT OF SCIENCE AND TECHNOLOGY
MUSEUM OF HISTORY AND TECHNOLOGY
SMITHSONIAN INSTITUTION

A museum of physical science, that is, physics, chemistry, and astronomy, maintains a collection of objects of permanent value relating to these fields. For convenience I shall, in comparing it with the museum of natural history, refer to it as a "science museum." These objects are collected for the same reason that the ethnological museum collects the artifacts of primitive man, to illustrate, among other things, the evolution of techniques, and to provide material documentation for the history of science and technology. They are also collected as memorabilia of great events in science, a purpose ideally identical to the first, as the great

events in science are fundamental steps in its development. These collections are exhibited, as are those of the natural history museum, because it is supposed that they may be interesting, and perhaps inspiring, to the museum-going public.

There are few such science museums in the United States, but there are many in Europe, where they have a history as long as that of the natural history museum. Both types appeared in the sixteenth and seventeenth centuries and have had a continuous history since. But whereas we find the natural history museum a relatively stable institution from the sixteenth century until today, the science museum has had a very checquered history. Because some of the peculiarities of the science museum today depend upon this circumstance, any attempt to characterize it must begin with an account of its history. Like the museums of natural history, the first science museums were actually the collections, in this case of instruments, of active scientists, which were occasionally shown to interested persons. In some cases the useless elegance of the instruments leads us to suspect that they were kept mainly for show, by the prosperous citizens of the Renaissance who collected them, but the same can probably be said for the natural history collections.

As late as 1600 there were few scientific instruments other than compasses, clocks, and astrolabes, although these existed in considerable numbers and variety. The seventeenth century, however, was a great period for the invention of apparatus, and by its end a large proportion of our modern instruments existed in one form or another. Through the eighteenth century many of these were preserved, for there was a general conviction that it was important to keep examples of instruments and machines, as they were supposed to embody ideas of permanent utility. So the collections of instruments grew, and their *raison d'être* came to be that of a sort of taxonomic collection of science.

The ebullient nineteenth century abandoned this naive faith in the utility of man's obsolete handiworks. But the old instruments were now antiques of some venerability. They were generally maintained as historical relics, *objets d'art,* or merged into the museums of technology (agricultural products, models of inventions, and the like) which came into fashion in that century. The establishment of these often gigantic museums was a by-product of the international exposition movement, and, as some other grandiose institutions of that century, this one finally showed a tendency to collapse under its own weight.

During its first three centuries, therefore, the science museum changed its objective several times and tended, in general, to diminish its association with scientific research and to give greater emphasis to public exhibition. This process has continued into the twentieth century. Just what purpose the public exhibition was supposed to serve became increasingly

unclear, and concern with this problem led, early in the present century, to the emergence of a new type of museum, a systematic museum of instruments, including historical relics, organized so as to show at once something of the sciences and their history, with appropriate supporting exhibits of a lively character, such as dioramas and push-button experiments, to sweeten the taste of the dust of history. Such museums came into existence during the decades just before or after the first world war, in Austria, Sweden, and Germany, the one in the last-named country being the famous Deutsches Museum at Munich. Their effectiveness is generally acknowledged, and their pattern has since been followed in the modernization of some of the ponderous museums of science and technology in other countries, a development that is still in progress.

In the mid-thirties appeared yet another, and the latest, innovation in the exhibition of the physical sciences, in an institution even more enlivened by operating experiments and which did away with the dust of history altogether. This was the Palace of Discovery in Paris, devoted to the exhibition of science through demonstrators, operating exhibits, and animations, but not to the permanent collection of objects. It represents, essentially, a laboratory course extended in space rather than in time. As it does not collect objects, it does not meet the conventional definition of a museum, and does not call itself one. It would fall outside our concern were it not for the fact that this type of exhibition, rather than the science museum, is widely regarded today as the most effective way to exhibit the physical sciences and hence as the successor to the science museum. As we have as yet no succinct title for this type of exhibition, I shall distinguish it here as an "exposition of physical science."

Before this chronology of the science museum is concluded, note must be taken of the planetarium, for it is much the most common institution in this country for the exhibition of physical science. The mechanical planetarium, one of the most commonplace scientific devices of the sixteenth and seventeenth centuries, had largely declined in popularity when it received a revival through the invention of the optical planetarium by Walther Bauersfeld in 1923. The first such planetarium was installed in the Deutsches Museum. Its growth in popularity since is too familiar to require emphasis. Although it was originally part of a science museum, the planetarium is essentially one exhibit out of such an institution as the Palace of Discovery. At the present time one of the principal preoccupations of those concerned with planetariums seems to be with what sort of exhibition should be added to the planetarium itself. Such questioning requires a decision as to whether to emulate the science museum (as exemplified by the Deutsches Museum) or the exposition of experimental science (as exemplified by the Palace of Discovery). The planetarium, in short, fits into the pattern that emerges from the history of the science

museum and shows similar indecisions as to its objective.

Inasmuch as the newest type of "science museum" is not a museum at all, our consideration of the history of this type of museum leads to the question of what its future may be. Museums of the type of the Deutsches Museum are now almost invariably supported by national governments, and countries that have had no museums of this type are now founding them. Thus the science museum appears to be firmly entrenched as a national institution. But it appears to be waning rapidly as a local or private institution, at a time when the public exhibition of science is flourishing as never before. Most local or private science museums are in various stages of transition towards the exposition of experimental science or of modern technology, neither of which involves the permanent collection of objects. There appears to be a trend in the same direction among planetariums.

The question of whether or not the Palace of Discovery represents "the wave of the future," as appears now to be the general opinion, does not fall within the scope of my subject. If this opinion is justified by events, then it seems likely that the science museum of the future will be an institution of the national government, as are the national archives or a military museum, that it will be replaced at the local level by the exposition of experimental science. It remains problematical how extensively large expositions of this type can be maintained, under the pressure of the necessity of constructing, maintaining, and continuously changing a large number of operating exhibits. The Palace of Discovery, which is the only full-scale example, has peculiar advantages, being in a centrally located metropolis which is also the national capital and enjoying the support of the largest university in the country. What can be said with certainty is that the exposition of experimental science is far from the first attempt to devise a new way for the exhibition of the physical sciences. The dislocations attendant on reorganization and reorientation have long been the chronic ailments of the science museum.

This lack of continuity of objective has come to constitute a fundamental difference between the science museum and the museum of natural history. Few, if any, museums today are indifferent to public appeal, but the more they are thought to exist only for public exhibition, the more they are cast adrift on the stormy sea of conflicting opinion as to what the public wants or should want. As a museum preëminently for exhibition, the science museum has been a favorite institution for experimentation by those who have wanted to make the museum a more dynamic factor in popular culture, or a more valuable adjunct to the schools. As we are not agreed upon the functions and methods of the schools themselves, or upon the relative importance of the two words in the phrase "popular culture," it is not surprising that we have not settled the question of the

science museum. But it seems to me that a most remarkable feature of this repeated process, and one that has been generally overlooked, is the absence from these discussions of the professional science museum curator. He has not been shut out. Rather, in the environment that I have described, he has never come into existence.

It is by no means coincidental that this lack of continuity in the objective of the science museum has been accompanied by a lack of continuity of staffing. Lacking academic associations, the science museum has had no obvious source of curatorial personnel. Lacking a generally agreed upon objective, it has never had clear standards of staff performance. Lacking both, it has failed to offer sufficient incentive for the retention, over a long period, of the services of curators of high competence. It was once supposed that the curatorship was appropriate for a scientist, but few scientists thought so, as the museum was inevitably in arrears of the forefront of science. This led to the conclusion that the curator should be an historian. But, until recently, neither the history of science nor the use of objects as documents had much appeal to the professional historian. The latter situation has now changed. The rise of the profession of historian of science provides an appropriate source of professional science museum curators, and the museum collections an important body of documentation for their research. Such work as has been accomplished in the history of science relates largely to the history of ideas. Among those parts of the field that still lie virtually untouched, and for which the science museum is particularly well suited, is the history of scientific instruments and their role in the development of science. As science has advanced from the era of string and sealing wax into that of incredibly complex and costly laboratory equipment, studies of the place of the instrument in scientific research are today much to be desired. People on the Smithsonian staff who are concerned with the exhibition of the physical sciences are expected, as are their colleagues in natural history, to make contributions to the increase in our fundamental knowledge in their fields of specialization. It is hoped not only that these contributions will be valuable, but that this research incentive will give us the staff continuity which the science museum has in the past so notably lacked. We are encouraged to believe that this hope will be realized by the example set in recent years by the national science museums of England and The Netherlands.

But the Smithsonian is a national museum of the type of the Deutsches Museum. What of the more numerous local museums and planetariums which, as I have indicated, appear now to consider the Palace of Discovery a more appropriate model? Can the exposition of experimental science achieve the staff continuity which the science museum has lacked? Can it surmount these difficulties by employing professional teachers, and

giving them research in laboratory teaching as an incentive? Perhaps, but not certainly. Does a museum or exposition really provide as good an environment for research in laboratory teaching as we already have in a school laboratory? The primary considerations in an exhibit are simplicity and durability, and the designer's ingenuity is almost inevitably diverted from the subject of the demonstration to the mechanics of making it work under museum conditions. The "students" of an exhibit are anything but amenable to discipline. Are not these exhibitions really more comparable to a theater than to a school? Are not exhibits subject to the same necessity of balancing information against showmanship, in an attempt to transmit a message which must be delivered quickly and simply, if it is to be delivered at all? Indeed, is not a museum or exposition subject to the problems of the theater in an exaggerated form, as its audience is standing, not sitting, in an area where a multitude of "shows" are simultaneously competing for his attention? If these queries are answered in the affirmative, the future of the exposition of physical science is as uncertain as have been all earlier attempts to operate a science museum for the principal purpose of public exhibition.

There is no obvious reason why a museum or exposition of science should not be exclusively concerned with exhibition. There is, in my judgment, a powerful, if less obvious, reason why no permanent institution for the exposition of physical science has yet enjoyed a high reputation for a long period of time. This is the failure, in practice, of exhibition alone to provide sufficient incentive for the retention of a staff of high competence. Such a staff can be assembled for the objective of building such a museum, but not for maintaining it, if its sole aim is exhibition. Unless the science museums and expositions of today develop an incentive equivalent to the research which maintains the essential continuity of the natural history museum, they will continue to be subject to the periodic, and increasingly expensive, reorientations of the past.

As has been noted, the emergence of the history of science as a professional discipline offers a solution to this problem for the science museum of the traditional sort. It is possible that the same solution might serve the exposition of experimental science, if the management of such an institution sees fit to add this type of research to its program. For the order of exhibits in such a museum is in practice nearly chronological, and the historical method is presently gaining favor in the teaching of physics. In any case, the exposition of experimental science is a direct descendant of the science museum, and must solve what I believe to be the fundamental problem of that museum, the development of an incentive other than exhibition which will assure an essential continuity of staff.

III/4 1960

Seven Lighting Problems; Seven Solutions

ROBERT T. HATT, DIRECTOR
CRANBROOK INSTITUTE OF SCIENCE
BLOOMFIELD HILLS, MICHIGAN

Although there is an extensive literature on museum lighting, particularly as regards the exhibition of paintings and sculpture, every natural science museum comes up against problems which do not find an answer in the published experiences of others. The staff of Cranbrook Institute of Science, faced with such problems, has developed a number of original ways of meeting them. Certain of these have wide enough applicability to merit description. They are the subject of the present paper.

PROBLEM ONE

To exhibit translucent minerals in a manner to reveal best their inner patterns.

SOLUTION

Mica with inclusions, polished thin slabs of agate, calcite, and tourmaline, cubes of clear fluorite, and similar materials lend themselves well to back-lighting. Natural lighting is largely excluded from our exhibition halls, and, for this reason, as well as because of the inconstant character of outdoor light, we used artificial illumination.

In building this case (Fig. 1) we hung the front glass on side hinges. Behind this were placed four-inch-wide shelves of quarter-inch plate glass, fitted into aluminum channels in the side frame. Behind these shelves, which carry the specimens, was placed standard double-hung aluminum window sash, glazed with opalescent glass. Light was provided by thirty-watt fluorescent tubes placed vertically on three-inch centers, two inches behind the frosted glass and in front of a white reflector (Fig. 2). The result is an almost perfectly diffused light source, bright enough to show the minerals well, yet not so bright as to disturb one's eyes. No great

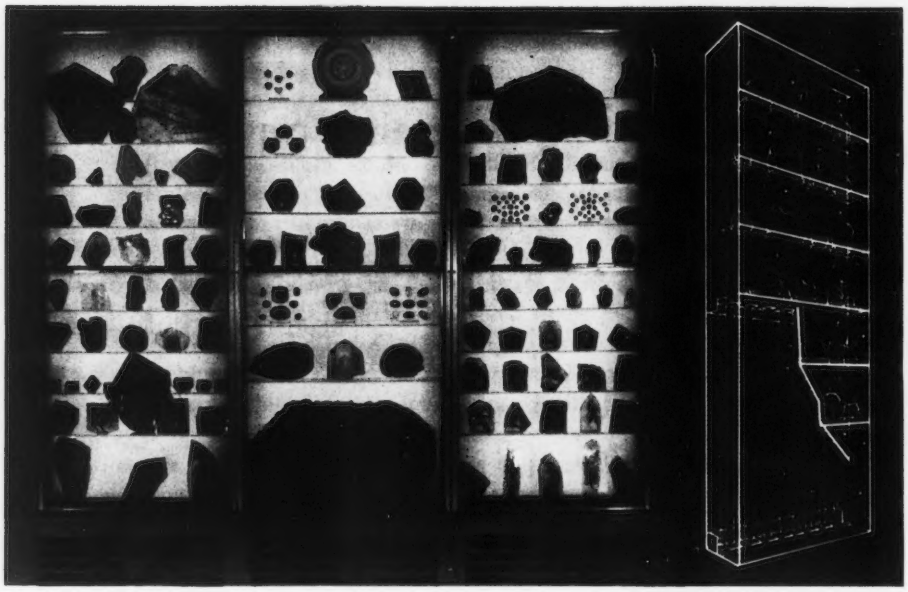


Fig. 1

Fig. 2

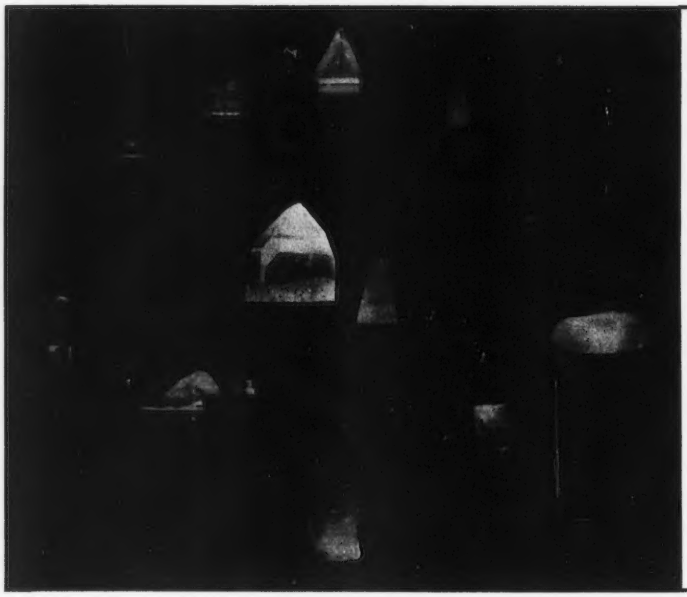


Fig. 3

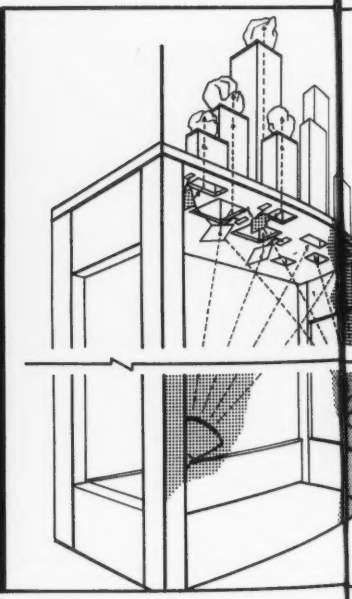


Fig. 4

Fig. 5

Fig. 6

amount of heat is given off by the tubes, and what little there is rises behind the cases into the room exhaust system.

The tubes are serviced by our swinging open the case front, removing minerals and glass shelves as required, and raising or lowering the sash to gain access to the light box.

In 1934, when the case was first developed, incandescent bulbs made it like a drying oven. Its present form dates to 1939, when more efficient lights were available.

Fig. 1. Minerals as transparencies. Labels are on the sides of the cases.

Fig. 2. Simplified diagram of the structure of the mineral transparency case. The case is of plywood.

Fig. 3. Base-lighted minerals.

Fig. 4. Scheme of lighting of the minerals shown in Figure 3. Some mirrors are omitted in this drawing, for simplicity.

Fig. 5. Base- and top-lighted models.

Fig. 6. Lighting plan of the "Progressive Organization" case.

PROBLEM TWO

To show such translucent minerals as are set off to best effect when placed before a dark background and internally lighted. The principle is that of the dark field microscope. In this manner we wished to exhibit beryl, spodumene, optical fluorite, tourmaline, topaz, and quartzes with phantoms, and other minerals.

SOLUTION

The stones were placed on glass-capped tops of hollow square columns, through which light was projected from below (Fig. 3). All light except that passing vertically through the minerals was masked out, and thus there was no surface or extraneous light to conflict with the transmitted light. In this installation the supporting hollow columns rest on a plate glass case floor, below which we set two 150-watt, Par-38, silver-based spot lamps. Individual mirrors below each column reflect light from one of the bulbs up through the columns and into the minerals (Fig. 4). This case was developed in 1950.

PROBLEM THREE

To provide illumination on the under side, as well as the upper surface, of varied small models (some translucent, some opaque), without glare to the visitor's eyes.

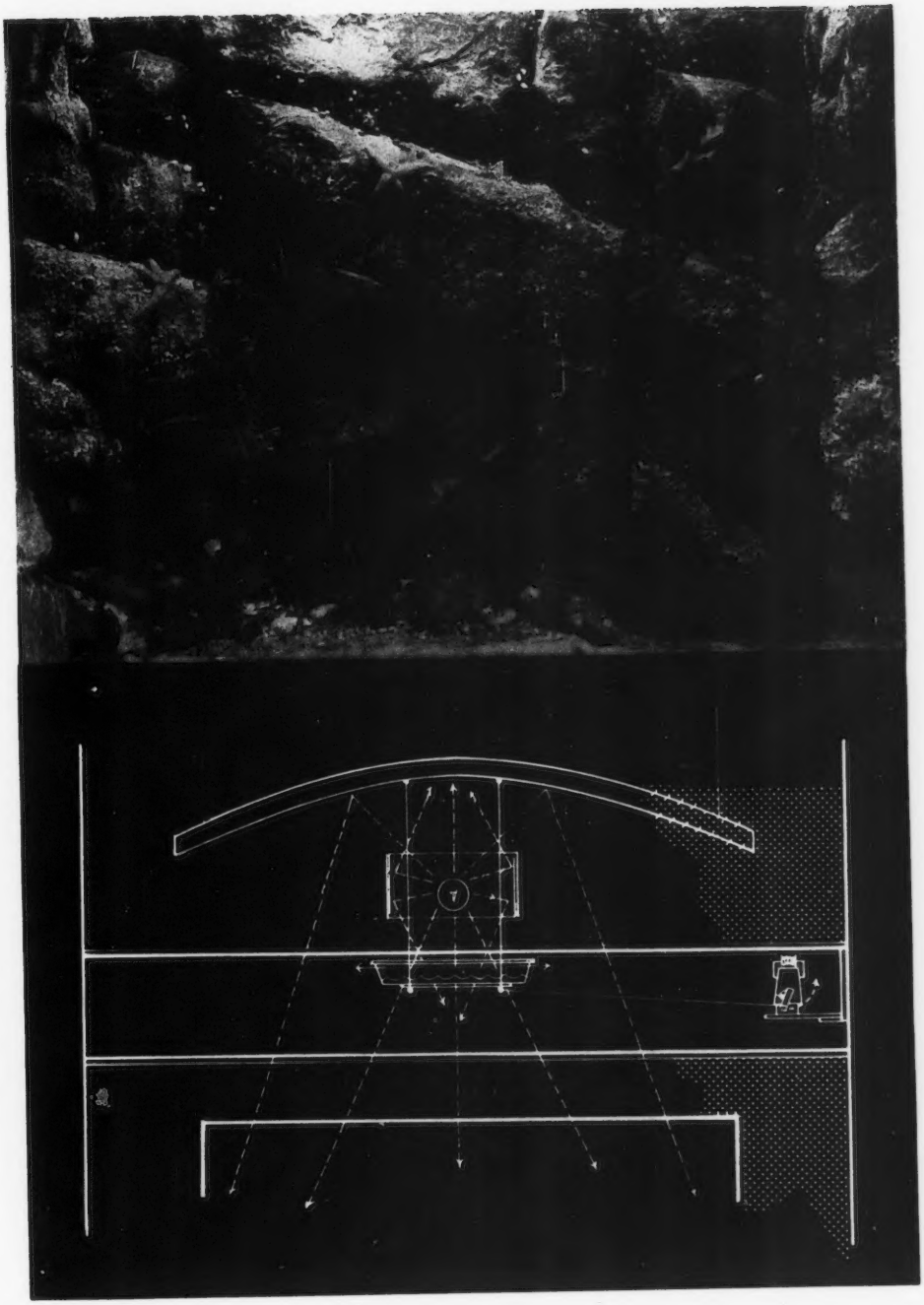
SOLUTION

As in the exhibit described above, light was brought up from below; in this instance through tubular columns and with slim-line tubes as the light source (Fig. 5). Because most of the objects to be shown were opaque, light needed to come from around the figures, yet not strike the visitor's eye. Our solution, which followed our seeing a display of glassware in a shop window on Fifth Avenue in New York City in, probably, 1952, was to sandwich a disk of Louverplas between two circles of glass that were supported within the tube at its top.

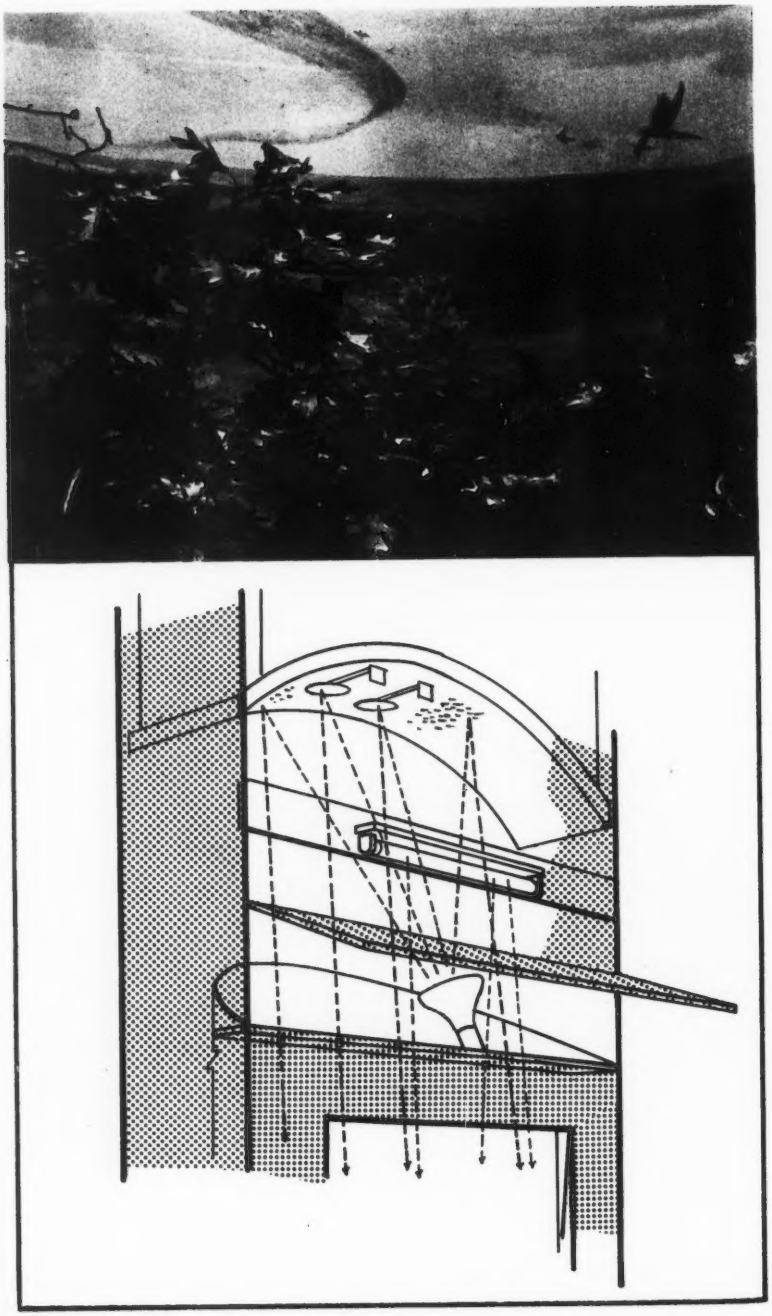
Louverplas is a laminated plastic with thin opaque layers, lying at about fifteen degrees from a perpendicular to the surfaces of the sheet. These layers serve thus as tiny louvers and, when correctly placed with reference to the line of sight, serve effectively to mask the light source. Light is also provided from above by spotlights. The effect is of well-lighted objects seen against a dimly lighted background. (See Fig. 6.)

Fig. 7. Exhibit of a tidepool on the coast of Maine to which moving wave patterns were first applied.

Fig. 8. The basic arrangement of the ripple-pattern equipment.



Figs. 7 and 8



Figs. 9 and 10

PROBLEM FOUR

To provide a wave-ripple pattern of light within exhibits of undersea life.

SOLUTION

The solution was simple; the result, very successful. Besides such lights as provided general illumination to the cases, we put in one 300-watt clear bulb to function as the sun and had this light pass through actual waves, and so on to the sides and floor of the exhibit. The waves were produced in ethylene-glycol (anti-freeze), which does not evaporate quickly, placed in a Pyrex tray sealed at the top. The tray rested in a cradle which was gently jerked, at intervals, by a chain fastened to an arm on the shaft of a small motor. (See Fig. 8.) The bulb that served as a spotlight also served for general case illumination.

The system was first applied in 1939 to an exhibit dealing with the zonation of life between the tides along the Maine coast. Later it was used in a larger exhibit dealing with the community of a Bahamian coral reef. Here the basic plan was modified by our using two trays of liquid and reflecting the spotlight by way of mirrors over the trays.

PROBLEM FIVE

To attain uniform illumination in small habitat groups, with shadows limited to foreground material.

SOLUTION

The Institute faced the problem of making successful habitat exhibits in which the space available was quite inadequate for the usual lighting procedures. One must in such groups have flat-lighted backgrounds, yet usually, too, a shadow pattern within the three-dimensional zone, and shadows must appear as though stemming from one source at infinity (Fig. 9).

The space for these exhibits, with which we were here concerned, limited backgrounds to a height of eight feet from the floor, a width of eighty inches, and a depth, in some instances, of as little as thirty inches. The tie-in between the painted background and the three-dimensional foreground material required, of course, the greatest skill and understanding of the problems of color perspective and of the maintenance of perspective on the curved backgrounds. The lighting problem, which seemed insoluble, found a good answer about 1940.

Fig. 9. A shallow habitat group to which dome lighting is applied.

Fig. 10. Dome lighting for even diffusion combined with shadow-producing, mirror-directed bright light.

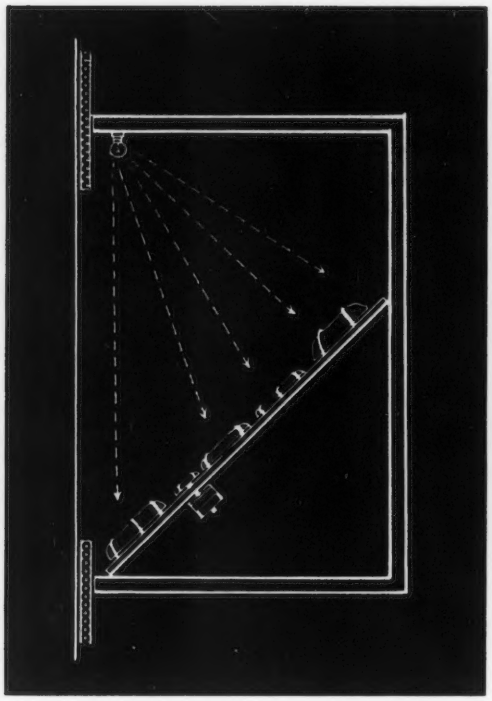


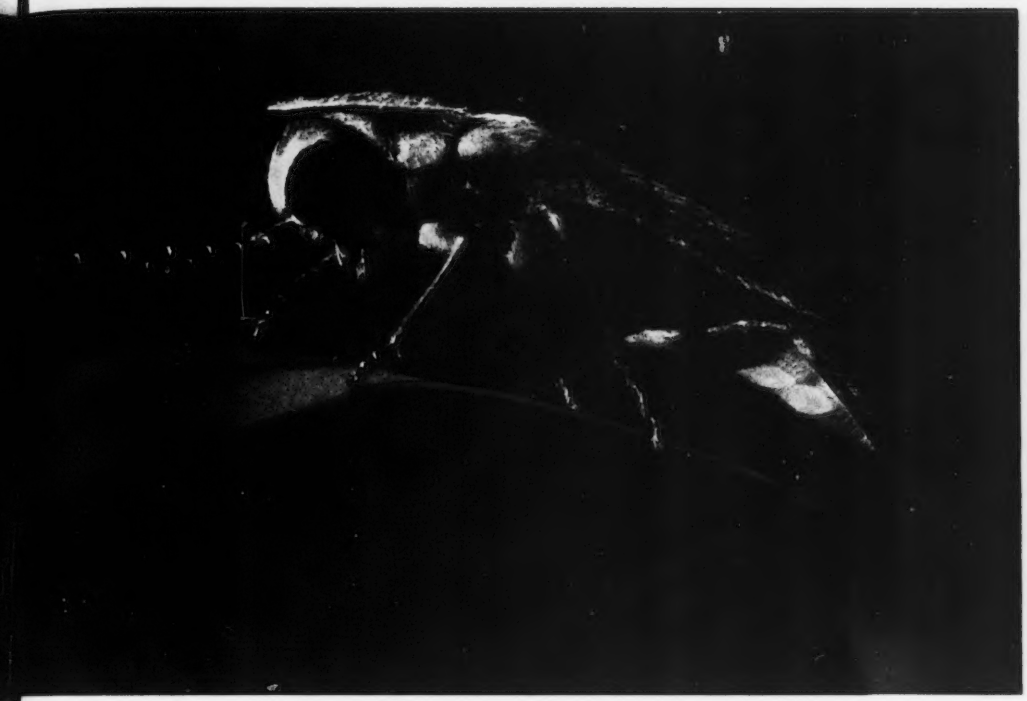
Fig. 11

Fig. 12

The basic solution (Fig. 10) was the provision of a reflective surface (a sector of a doubly truncated oblate ellipsoid) with good reflective qualities, focused downward over the group. Into this we pointed a single light bulb of proper size (usually a 300-watt, silver-based bulb). The reflecting surface was produced by our making a wooden armature, screen-facing it, plastering this, then coating the surface with a high-reflection, white paint. Onto this, while still wet, was sprinkled a flaking of mica. This gave splendidly distributed general illumination which could be supplemented with tubular lights near the front glass. To obtain shadows we merely placed one or more downward-facing, rear-view, truck mirrors in front of the reflecting dome and bounced light from the spot via the mirrors into the area where shadows were needed.

PROBLEM SIX

To give low-heat, point-light, source illumination to opals. Gem opals, as is true also of faceted stones and translucent crystals, show up to their



best only when the light source is a point of light. The usual silver-based spotlights are not satisfactory for opals, because the radiant heat that they produce can be destructive to these stones by desiccating them. Even when the bulbs were placed outside the case, and at a distance from the stones, we found the increase in temperature serious when the light was adequate.

SOLUTION

Our solution (which followed many failures) involved providing a strip of six-volt flashlight bulbs on three-inch centers, eight to ten inches from

Fig. 11. Section of a typical shadow-box arrangement for gem opals. A small motor turns one of them to illustrate changing color patterns.

Fig. 12. The model of the female firefly with luminescent abdomen.

the stones. Although the little heat produced by these bulbs is quickly dissipated, we have given additional protection to the life of the high-priced stones by providing a switch to be operated by visitors to turn on the lights, and a cut-off switch which darkens the case after three minutes. The opals are further protected against drying by a forced draft of humidified air being circulated through the case. The present lighting system was completed in 1954.

PROBLEM SEVEN

To produce a life-like representation, enlarged in size, of the flashing of fireflies, some in flight. A female was to be resting on a blade of grass, flashing her "come hither" signal. One male, in flight, facing away from the female, was to flash a non-responsive signal. Another, air-borne and facing the female, was to flash the "I'm coming" code. The bodies of the flies were to be eight inches long.

SOLUTION

We developed bodies with head and thorax of balsa wood (Fig. 12). Solid Lucite abdomens were carved, satin finished, and fitted to the balsa wood parts with beeswax. Then three-volt flashlight bulbs were buried in the balsa, just forward of the lucite and a light green filter. The bulbs were connected to two thirty-six-gauge wires, leading to microswitches above the case, their sequence and duration of contacts controlled by a clock motor. A doorbell transformer was, of course, required to step down the line voltage from house current. These same electric wires provided the only (and almost invisible) support to the flying insects. To replace bulbs (required about once in three years), it is necessary to remove the abdomens and reset them. The equipment has developed no fault since its completion in 1951.

It is difficult to give credit fairly on these several projects, for in most of them several minds and more than one pair of hands were at work. The exhibition and construction personnel of the Institute, over a period of quite a few years, are, however, those to be principally credited. The names of Messrs. Dudley M. Blakely, James H. Carmel, and Donald E. Tompkins would be prominent in any arrangement of credits.

III/4 1960

Mounting Geological Specimens

C. A. SIZER, KEEPER OF GEOLOGY
CITY MUSEUM AND ART GALLERY
LEICESTER, ENGLAND

INTRODUCTION

In the new Geology Gallery under construction at the City Museum, Leicester, England, an attempt is being made to display the varied geological processes and the conclusions drawn from them in a logical sequence. The material is being exhibited in wall cases with a minimum of table cases, and, as it is desired to make the mounts as inconspicuous as possible, many difficulties have been encountered in supporting the specimens.

Geological specimens are of such diverse character that mounting for display is probably more difficult than with any other class of museum material. There is no universal method that can be applied to any rock, mineral, or fossil of whatever weight, shape, size, or state of preservation.

The prime requirement of any method of support is that it should be easy to apply and to remove without damage to the specimen. In use it should be flexible enough to allow the specimen to be mounted in any desired position, as inconspicuous as possible, and preferably completely hidden, allowing an unobstructed view of the material displayed. Some authorities maintain that the lack of a visible means of support detracts the attention of the public away from the actual specimen to a contemplation of the method of mounting, but it seems preferable to conceal the supports if at all possible.

COMMON TECHNIQUES

A survey of the methods at present in use or previously published suggests that they are not all entirely suitable for supporting all types of material in any position and that their uses are strictly limited.

The types of mount commonly employed can be grouped into two

main categories: (1) devices for stabilizing or supporting specimens on horizontal or gently inclined surfaces; and (2) devices for attaching specimens to vertical or steeply inclined surfaces.

The almost exclusive display of geological material on horizontal or gently sloping surfaces was current practice for so many years that numerous methods have been devised to overcome the difficulties encountered. Prominent among the earlier methods was the practice of gluing the specimens to wooden tablets, but this technique has been largely abandoned owing to the danger of damaging the specimens during removal. The material was often displayed in the position in which it stuck best and not in the position in which it looked best, but this was a less serious drawback.

Another early method was the habit of placing the specimen on or inside retaining pins. This is often unsightly and may be dangerous if used for pyritized material, leading to the decay and ultimate disintegration of the specimen. An ingenious modification of this method was developed in the National Museum of Wales and described by F. J. North, in 1923, at the Hull Conference of the Museums Association. North suggested the drilling of small holes into the matrix of the specimens and the insertion of small pins, leaving about a quarter of an inch protruding which could be pushed into the backboard to hold the specimens securely. If the holes were drilled obliquely, quite heavy specimens could be stabilized in this manner, and in such cases in which it was impossible to drill the specimens a similar result was obtainable by cementing drawing pins to the under surface. By a variation in the length and position of the pins, specimens could be mounted in almost any attitude. With this method the supports are almost invisible, the material can readily be removed for examination, and there is little danger of damage to the specimens.

Perhaps the commonest mounts used in desk cases are variants of those employed in the Geological Survey Museum and the British Museum (Natural History), in which the specimens are supported in depressions in a plaster base of uniform pattern. This technique has been thoroughly described by Hester and Dewar (1935) and appears to be a development of a much older technique in which the specimens were actually embedded in the plaster. The main disadvantage of the older method is the difficulty of subsequently removing the plaster without damage to the specimen and without leaving traces of the plaster. In its modified form specimens can be mounted to show any aspect and are readily removed, but the base, even when painted the background color, is rather obtrusive.

An interesting development of this method is described by Claringbull (1948a), employing Perspex instead of plaster for the base. The Perspex is blown into a dome or blister and molded to the shape required by

gently placing the specimen in position, removing it, and allowing the Perspex to harden. When trimmed these bases are much less obtrusive and are capable of supporting heavy weights. With the use of this method, a *Nautilus* weighing nearly half a hundredweight has been exhibited in the Evolution Gallery at Leicester and shows no deterioration after more than two years. Claringbull mentions also the use of angular Perspex stands which are far more elegant than some of the wooden ones formerly employed.

With suitable modifications some of these methods can be adapted for attaching specimens to vertical or steeply sloping surfaces. Pins can be used, but often they cannot be made to conform to the contours of the specimen, frequently they detract from its appearance, and the weight they can support is strictly limited.

Heavier specimens were formerly wired directly to the backboard, but such a method is very unsightly. To overcome this drawback, Palmer (1936) suggested the use of wire clips similar to proprietary shop fittings. These were screwed directly to the backboard and were so designed that they prevented the specimens from swiveling. North (*in* North, Davidson, and Swinton, 1941) suggests a simpler type of wire support or small metal shelves with turned-up edges. Wire clips can support only a limited weight, and both the wires where they grip the specimen and the shelves where they support it are visible. To some extent this effect can be made less conspicuous by painting the wires to conform to the color of the specimen. A pleasing result has been obtained in the Royal Scottish Museum by coating the ends of the wires with Fibrenyle to give a rougher surface for painting.

Claringbull (1948b), in describing mounts for gemstones, mentions the use of strips of Perspex which can be molded to the shape of the specimen and screwed to the backboard, and these may be superior to the Y-shaped phosphor bronze clips described by Payler (1936). The satisfactory use of Perspex is, however, limited by the weight it is required to carry, heavy weights causing bending and possibly ultimate fracturing of the support. Several strips may be required for heavy specimens, and the light reflections from their surfaces can be very obvious.

North's method of drilling the specimens and supporting them with pins is quite pleasing, and a development of it has been used with considerable success for large specimens. Much larger holes are drilled into the matrix with a masonry drill, and quarter-inch dowel rods are fixed in position with polyvinyl acetate dispersion. An alternative adhesive must be selected for pyritized material, as the dispersion contains water which may promote pyrites decay. The rods pass through the backboard and are fixed behind by the gluing of wooden blocks over them. With this method, many specimens, including a fossil fish weighing twenty

pounds, have been satisfactorily mounted in the new gallery. By a careful positioning and adjusting of the length of the rods, the manner of mounting can be entirely hidden, and the specimen can be mounted in almost any position. The limitations of this method are realized when the matrix is too hard to be drilled easily and there is not enough of it to allow the holes to be drilled without danger of damage to the specimen.

Geological material can be glued directly to the backboard, but such a method of mounting is not recommended. The use of epoxy resins such as Araldite and impact adhesives is particularly deplorable, as it is virtually impossible satisfactorily to remove these adhesives once they have been applied.

A modification of this method consists of fixing bolts, screws, or other means of support to the specimen and attaching these to the backboard. The adhesives commonly used were carpenters glue, button shellac, or cow gum. In a report of a Museums Association Demonstration Course (Anon., 1940) the late Dr. M. B. Hodge's method of fixing nuts and bolts to specimens by means of gauze or perforated zinc held by shellac is described. As shellac is relatively brittle, the support of large specimens by this method was often attended by disastrous results. However, it is satisfactory for small specimens that are not to be displayed for any great length of time. It is a development of the technique advocated by C. A. Reeds (1920) who used a mixture of sand, cement, and molten sulphur which, except for ease of application, was in some ways superior. It was certainly more permanent.

THE FIBRENYLE TECHNIQUE

A great many geological specimens can be satisfactorily displayed on horizontal or vertical surfaces by the methods outlined above, and often a method can be chosen whereby the actual means of support is hidden, but difficulties are still experienced in the mounting of two main classes of material on vertical backboards. Fossils or minerals that have little adherent matrix thus must not be drilled for the insertion of pins or dowel rods, unless they have been collected solely for display, and igneous and other rocks that are too hard to be drilled easily present difficulties.

To overcome these problems, experiments were carried out in the Geology Department of the Leicester Museum to discover a suitable mounting technique for this material. The most promising line of research

Fig. 1. Mounting rocks with Fibrenyle. Part of the Fibrenyle is cut away to expose the polystyrene tube.

Fig. 2. Mounting small fossils with Fibrenyle, with the use of a bolt.

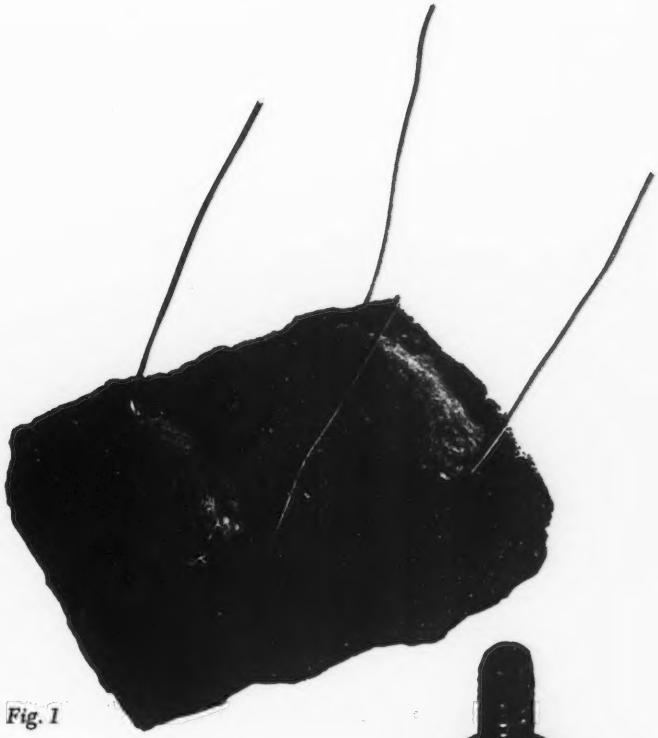


Fig. 1

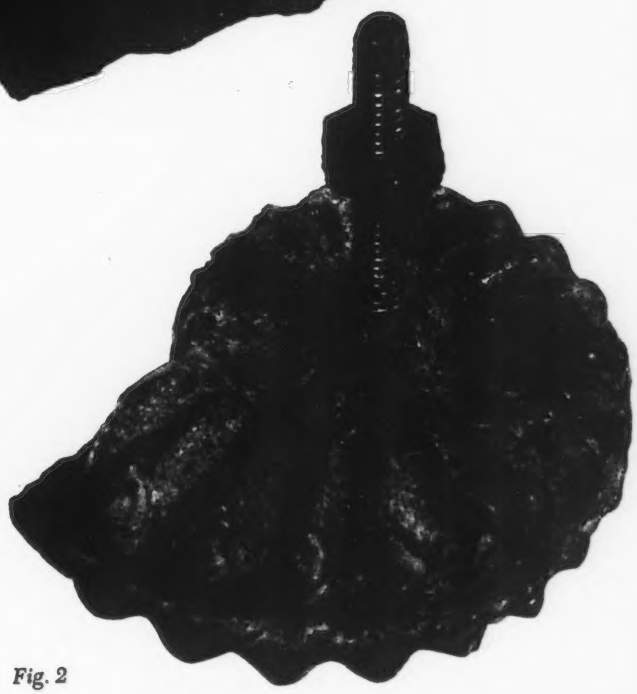


Fig. 2

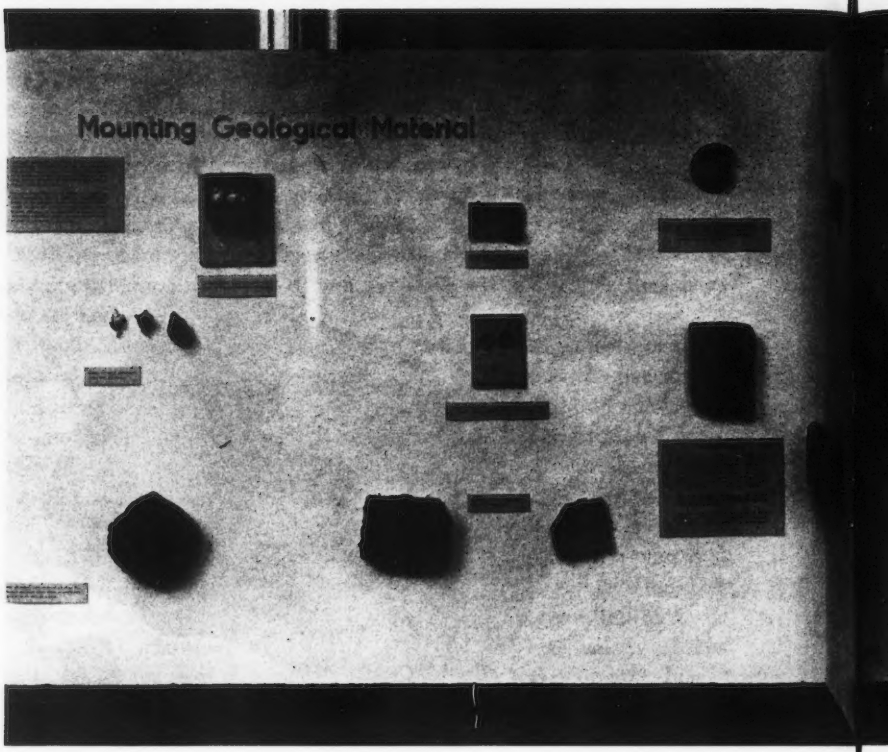


Fig. 3

seemed to be a development of a method whereby some type or types of support could be cemented to the back of the specimen and attached to the backboard. Any adhesive used had to be non-brittle to give permanency and of high tensile strength to support a heavy weight. In addition it must not endanger the specimen and should be easily removable at any future date.

The adhesive eventually chosen was Fibrenyle[1] Dough, an emulsified vinyl resin, mixed with jute fibers. As it will not take up water, it can be used for supporting pyritized material without danger of its causing pyrites decay. Unlike most glues and shellacs, it improves with age and has an indefinite shelf life. It is easily workable and dissolves in most organic solvents, including methylated spirit, acetone, and toluene. Providing any

[1] Fibrenyle can be obtained from Messrs. Fibrenyle Ltd., 157 Dukes Road, Western Avenue, London, W.3, England.

surplus is not left exposed to the air for too long, there is very little wastage. Its application to the repair of fossils has been described by Newman (1955).

The mounting procedure is very simple. After any necessary cleaning, the specimens are dried thoroughly, as Fibrenyle will not adhere to a damp surface. If wire is to form the support, two right-angled bends are formed, and the central portion is made to conform to the contour of the specimen. The area of attachment is given a coating of the solvent or of a concentrated solution of Alvar[2] (a vinyl resin) in amyl acetate and ethyl alcohol (four parts to one part by volume). The wire is placed in position, covered to a depth of approximately a quarter of an inch with Fibrenyle softened with Alvar, and the whole is covered with the resin. After two hours or so, when the Fibrenyle has begun to harden, it is pressed firmly onto the specimen, and any tendency for it to lift is counteracted by redamping with Alvar.

It has been suggested that Fibrenyle tends to become brittle after about five years, so the use of a vinyl resin seems preferable to the use of the solvent alone, the resin binding the jute fibers together.

The specimens can usually be handled with safety after ten to twelve hours, but normally they are allowed two to three days in which to dry thoroughly before being mounted.

There is a tendency for the wire to cut through the feather edge of the Fibrenyle, if the specimens are unduly heavy, but such difficulty can be avoided by running the wires through a fiber or polystyrene tube embedded in the Fibrenyle (Fig. 1). A similar effect is seen if the bends in the wires are rounded and not sharp angles.

This method has proved very satisfactory for mounting fossils with little matrix and hard igneous rocks. With a single wire one-sixteenth of an inch in diameter, a specimen of compact syenite weighing eight pounds has been adequately supported. This was the test piece on which most of the preliminary experiments were performed. For display it is preferable to have two independent wire supports, especially if the specimen is of any considerable size. The ends of the wires are carried through holes in the backboard and twisted together at the rear. If insulation board or other soft material is used as a backboard, it is essential to have a small strip of wood between the wires, which rest in slots in the

[2] Alvar can be obtained from Messrs. Shawinigan Ltd., Marlow House, Lloyds Avenue, London, E.C.3, England, or Shawinigan Products Corporation, 350 Fifth Avenue, New York 1, New York.

Fig. 3. The Leicester Museum exhibit at the Geologists' Association Reunion in London in 1959.

wood, to prevent their cutting the material when they are tightened. The final position of the specimen can be adjusted if necessary with the use of pins or by gluing small wooden blocks to the backboard behind it.

With light material, wires appeared to be rather clumsy. As an alternative flat-headed, countersunk bolts, two inches by three-sixteenths of an inch, were attached to the backs of the specimens with Fibrenyle. An ammonite prepared for display in this manner is shown in Figure 2.

When specimens are taken off display, all bolts and wires can be easily removed by softening the Fibrenyle with one of the solvents, and the last traces of Fibrenyle can be removed with a wad of cotton soaked in solvent.

CONCLUSIONS

The Fibrenyle technique has proved adequate for mounting geological and possibly other material that is difficult to support satisfactorily on vertical surfaces. It is easy to apply and remove, causes no damage to the specimens, and adheres to both rough and smooth surfaces. In many cases it can be used as an alternative to, or to replace, methods formerly employed, but it is not of universal application and should not be used to support extremely brittle or friable material which may collapse under its own weight. There is no method of mounting such material on a vertical surface without prior impregnation, which is frequently undesirable. This new technique was demonstrated at the Annual Reunion of the Geologists' Association in London in 1959, where it aroused considerable interest (Fig. 3).

When geological material is to be mounted, each specimen in turn must be considered, and "in deciding the precise means to be adopted one should aim at security without damage to the specimen, and invisibility of the mounting medium employed" (North, 1923).

ACKNOWLEDGMENTS

I am indebted to Mr. T. A. Walden, Director of the City Museums, Leicester, for much helpful advice, and to Mr. R. D. Abbott of the Antiquities Department, for the photographs illustrating this paper.

REFERENCES

Anon.: *A wartime museum course.* Mus. Jour., London, vol. 40, pp. 219–223. 1940.

Claringbull, G. F.: *Perspex supports for exhibition.* Mus. Jour., London, vol. 48, pp. 8–10. 1948a.

Claringbull, G. F.: *Mounts for gemstones on vertical surfaces.* Mus. Jour., London, vol. 48, p. 51. 1948b.

Hester, S. W., and W. Dewar: *Plaster mounts for exhibiting fossils.* Mus. Jour., London, vol. 35, pp. 262–266. 1935.

Newman, B. H.: *The use of Fibrenyle.* Mus. Jour., London, vol. 55, pp. 65–66. 1955.

North, F. J.: *Some methods of mounting geological specimens.* Mus. Jour., London, vol. 23, pp. 120–125. 1923.

North, F. J., C. F. Davidson, and W. E. Swinton: *Geology in the museum.* Oxford, Oxford University Press. 1941.

Palmer, M. G.: *Mounting rock specimens.* Mus. Jour., London, vol. 36, pp. 17–19. 1936.

Payler, D.: *Gemstone exhibit in Birmingham Museum.* Mus. Jour., London, vol. 36, pp. 301–304. 1936.

Reeds, C. A.: *Mounting geological specimens with sulphur.* Mus. Work, Washington, vol. 3, pp. 62–65. 1920.

CURATOR BOOK REVIEWS

Of Museums and Museum Work, A Bibliography. *Compiled at the Milwaukee Public Museum by Stephan F. Borhegyi and Elba A. Dodson. Published by order of the Board of Trustees, Milwaukee, Wisconsin, 1960, 72 pp.*

As the introduction states, the purpose of this bibliography is to fill a long-existing need for a guide to source material on museums and museum work. It covers the entire museum field, with a representative selection of material in each area. For the purposes of the publication, the museum field has been arbitrarily (and logically) divided into sixteen broad areas, with subdivisions where necessary to facilitate the finding of wanted information. Under each section, books and pamphlets are listed first, by author, followed by periodical articles listed alphabetically, by the title of the article. An extensive author index adds to the effective use of the publication.

The major divisions of the bibliography are as follows: I. *Museums—General.* International museum cooperation, periodicals in the museum field, directories, bibliographies. II. *Buildings.* Museum architecture, interior design, air conditioning, lighting, museum security. III. *Organization and Administration.* Governing bodies, public support, other financial considerations. IV. *Personnel and Salaries.* Professional standards, policies concerning salaries. V. *Training for Museum Work.* Methods, apprenticeships, and so on. VI. *Educational Work of Museums.* Museum service to community, schools, services for teachers. VII. *Radio, Television.* Increasing museum audience through radio and television, audio-visual aids. VIII. *Public Relations.* Cooperation with community. IX. *Exhibits—General.* Effectiveness, educational value of specific types of exhibits. X. *Cataloging, Loans, Storage.* Record-keeping process in acquisition and dis-

position of objects. XI. *Packing and Shipping.* Traveling exhibitions, transportation and care of museum objects. XII. *Importing and Exporting.* Problems of international sale and exchange, insurance. XIII. *Museum Categories.* Museums by subject, size, function, material, specific problems. XIV. *Techniques.* Processes involved in preparing and restoring specimens, setting up displays, and similar subjects. XV. *Foreign Museums.* Recently published material on museums outside the United States. XVI. *Dealers.* Supply sources, transparencies, specimens, materials.

The seventy-two pages of this bibliography are packed with the kind of information that museum people are always writing to each other to find out about. The bibliography should, in fact, have been bound in a tougher, more durable cover, for it will be in constant use on the desks of museum administrators, education chairmen, curators, teachers, building superintendents, and all persons who are concerned with museums and their operation.

Dr. Borhegyi and Elba Dodson are to be congratulated for a fine compilation of material that has hitherto existed only in incomplete fragments in a three-by-five card file, the back of an envelope, or in some harried museum worker's memory.

W. A. B.

Directory of Museums in India. *C. Sivaramamurti. With a foreword by Professor Humayun Kabir, Minister for Scientific Research and Cultural Affairs. New Delhi, India, published by the Ministry of Scientific Research and Cultural Affairs, 1959, Rs 7.50.*

For those in the museum world who wish to increase their knowledge of world museology, there is, at long last, a complete up-to-date directory of Indian museums, listing all the Indian museums, their staff, their objectives, and their specialized collections. This last inclusion is of particular value to the art historian and scholar who wishes specific information or to borrow specimens for study or special exhibition. Another virtue of the directory is its interesting, short, historical, summary account of each museum, with a general historical review of the entire museum movement in India, starting with the work of the Asiatic Society of Bengal in 1784. Though the development of museums in India paralleled that of museums elsewhere in the world, enough documentation was available for a fairly complete history to be written. As interest grew in local "curiosities," India's first museum was founded in 1814 in Calcutta by Wallich, a Danish botanist. The museum movement soon came under the guidance of scholars who built up many repositories, coupled with private collections, which were eventually opened to the interested public.

Unfortunately, the Directory has a number of weak points, one of which the author mentions in his introduction. The review of the physical characteristics and purposes of each museum is not very objective, as it was written not by a disinterested individual or a selected committee of appraisal but by each museum itself. Naturally each institution has attempted to paint a glowing picture of its own activities which, in some instances, is misleading. Having visited a number of the included museums in 1958–1959, I found a few minor discrepancies in the text but realize that Shri Sivaramamurti has done a splendid job of gathering all this information in spite of many difficulties.

The other criticism I have is the use of a great many photographs of individual art ob-

jects. After all, the Directory is not a book on Indian art, and it would have been improved had photographs been included of museum activities, exhibitions, facilities, laboratories, and other items of greater interest to the European and American museologist.

The role of education as one of the prime functions of the museum has been neglected in the text and under the separate listings of the museums, although it has been stressed in Humayun Kabir's foreword. The author, Shri Sivaramamurti, is a well-known Sanskrit scholar and Indian art historian whose name has long been associated with the Indian museum movement. However, he, as well as other Indian museologists, has followed the traditional thinking associated with the established dictionary definition of "museum." Antiquarianism and scholarship have predominated in the objectives and philosophy of most Indian museums, though there seems to be a break-through that would indicate new thinking. As pointed out in an earlier article,[1] the museums of India still seem to cater to the initiated few, which is a luxury when education for the vast public should be the prime function. In this light, I truly hope that Professor Humayun's thoughts about the place of the museum in Indian education have some effect.[2]

L. P. W.

[1] See CURATOR, vol. III, no. 1, 1960, "The Situation of Museums in India."

[2] The "Directory of Museums in India" may be ordered from Mrs. Muriel Wasi, Deputy Educational Adviser, Ministry of Scientific Research and Cultural Affairs, New Delhi, India.

PICTURE CREDITS

Pages 294–295, Museum National d'Histoire Naturelle, Paris; page 297, Bo Bergstedt; page 298, Nationalmuseet, Copenhagen; page 301, Ralph C. Morrill, Peabody Museum of Natural History and The American Museum of Natural History; page 302, figure 5, Smithsonian Institution, Washington; page 304, figure 7, K. Rothplets; page 309, Museum of Comparative Zoölogy at Harvard College; illustrations in the article beginning on page 361, Cranbrook Institute of Science; illustrations in the article beginning on page 371, R. D. Abbott, Antiquities Department, City Museum and Art Gallery, Leicester, England; all others, The American Museum of Natural History.